Water Quality Criteria Report for Cyfluthrin

Phase III: Application of the pesticide water quality criteria methodology

Prepared for the Central Valley Regional Water Quality Control Board

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Table of Contents

List of Figures

List of Tables

List of acronyms and abbreviations

ACE	Acute-to-Chronic Estimation
ACR	Acute to Chronic Ratio
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BMF	Biomagnification Factor
CAS	Chemical Abstract Service
CDFG	California Department of Fish and Game
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CVRWCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
DHM	Dissolved Humic Material
DOC	Dissolved Organic Carbon
DOM	Dissolved Organic Matter
DPR	Department of Pesticide Regulation
EC_x	Concentration that affects x% of exposed organisms
FACR	Final Acute to Chronic Ratio
FAV	Final Acute Value
FCV	Final Chronic Value
FDA	Food and Drug Administration
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FT	Flow-through test
GMAV	Genus Mean Acute Value
HC_x	Hazardous Concentration potentially harmful to x% of species
IC_x	Inhibition concentration; concentration causing *x*% inhibition
ICE	Interspecies Correlation Estimation
IUPAC	International Union of Pure and Applied Chemistry
K	Interaction Coefficient
K_H	Henry's law constant
K_{ow}	Octanol-Water partition coefficient
K_p or K_d	Solid-Water partition coefficient
LC_x	Concentration lethal to *x*% of exposed organisms
LD_x	Dose lethal to *x*% of exposed organisms
LL	Less relevant, less reliable study
LOEC	Lowest Observed Effect Concentration
LOEL	Lowest Observed Effect Level
LR	Less relevant, reliable study
MATC	Maximum Acceptable Toxicant Concentration
N	Not relevant or not reliable study
n/a	Not applicable
NOEC	No Observed Effect Concentration
NR	Not reported
OECD	Organization for Economic Co-operation and Development

QSAR	Quantitative Structure Activity Relationship
pK_a	Acid dissociation constant
RIVM	National Institute of Public Health and the Environment, Bilthoven, The Netherlands
RL	Relevant, less reliable study
RR	Relevant and reliable study
S	Static test
SMACR	Species Mean Acute to Chronic Ratio
SMAV	Species Mean Acute Value
SR	Static renewal test
SSD	Species Sensitivity Distribution
TCE	Time Concentration Effect
TE	Toxic Equivalent
TEF	Toxic Equivalency Factor
TES	Threatened and Endangered Species
TU	Toxic Unit
US	United States
USEPA	United States Environmental Protection Agency

1. Introduction

A new methodology for deriving freshwater water quality criteria for the protection of aquatic life was developed by the University of California, Davis (TenBrook *et al.* 2009a). The need for a new methodology was identified by the California Central Valley Regional Water Quality Control Board (CVRWQCB 2006) and findings from a review of existing methodologies (TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009b). This new methodology is currently being used to derive aquatic life criteria for several pesticides of particular concern in the Sacramento River and San Joaquin River watersheds. The methodology report (TenBrook *et al.* 2009a) contains an introduction (Chapter 1); the rationale of the selection of specific methods (Chapter 2); detailed procedures for criteria derivation (Chapter 3); and a chlorpyrifos criteria report (Chapter 4). This criteria report for cyfluthrin describes, section by section, the procedures used to derive criteria according to the UC-Davis methodology. Also included are references to specific sections of the methodology procedures detailed in Chapter 3 of the report so that the reader can refer to the report for further details (TenBrook *et al.* 2009a).

2. Basic information

Chemical: Cyfluthrin (Fig. 1)
CAS: cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-=2,2-dimethylcyclopropanecarboxylate (unstated stereochemistry)
IUPAC: (*RS*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*R*,3*RS*;1*RS*,3*SR*)-3-(2,2-dichlorovinyl)-=2,2-dimethylcyclopropanecarboxylate

Chemical Formula: $C_{22}H_{18}Cl_2FNO_3$

CAS Number: 68359-37-5
CA DPR Chem Code: 2223
USEPA PC Code: 128831

Trade names: Aztec, Bay-FCR 1272, Baygon aerosol, Bayofly, Baythroid, Cyfoxylate, FCR 1272, Hidalgroc, Leverage, Responsar, Sofac, Tempo (ExToxNet 1995, FAN 2009, Tomlin 2003).

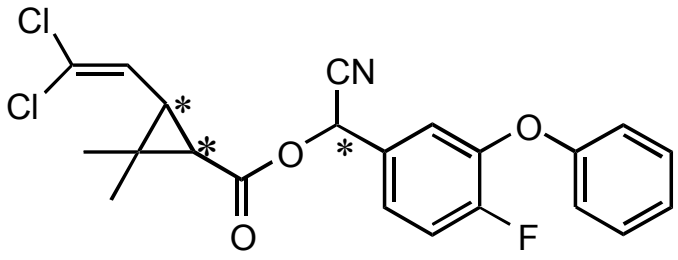

Figure 1. Structure of cyfluthrin, asterisks indicate stereocenters.

3. Physical-chemical data

Molecular Weight
434.3 Laskowski 2002

Composition
Technical grade (racemic mixture): 23-27% diastereoisomer I, 17-21% diastereoisomers II, 32-36% diastereoisomer III, 21-25% diastereoisomer IV (Tomlin 2003)
Diastereoisomer I: (*R*)-α-cyano-4-fluoro-3-phonxybenzyl (1*R*)-cis-3-(2.2-dichlorovinyl)-2,2-dimethylcyclopropane=carboxylate + (*S*)-α, (1*S*)-cis-
Diastereoisomer II: (*S*)-α, (1*R*)-cis- + (*R*)-α, (1*S*)-trans-
Diastereoisomer III: (*R*)–α, (1*R*)-trans- + (*S*)-α, (1*S*)-trans-
Diastereoisomer IV: (*S*)-α, (1*R*)-trans- + (*R*)–α, (1*S*)-trans-

Density
1.28 g/mL at 20°C Tomlin 2003

Water Solubility

Technical (racemic): 2.3 μg/L at 20°C	Laskowski 2002
Diastereoisomer I: 2.5 μg/L at 20°C (pH 3)	Tomlin 2003
Diastereoisomer I: 2.2 μg/L at 20°C (pH 7)	Tomlin 2003
Diastereoisomer II: 2.1 μg/L at 20°C (pH 3)	Tomlin 2003
Diastereoisomer II: 1.9 μg/L at 20°C (pH 7)	Tomlin 2003
Diastereoisomer III: 3.2 μg/L at 20°C (pH 3)	Tomlin 2003
Diastereoisomer III: 2.2 μg/L at 20°C (pH 7)	Tomlin 2003
Diastereoisomer IV: 4.3 μg/L at 20°C (pH 3)	Tomlin 2003
Diastereoisomer IV: 2.9 μg/L at 20°C (pH 7)	Tomlin 2003
Diastereoisomer IV: 2.9 μg/L at 20°C (pH 7)	Tomlin 2003

Melting Point

Technical: 60°C	Tomlin 2003
Diastereoisomer I: 64°C	Tomlin 2003
Diastereoisomer II: 81°C	Tomlin 2003
Diastereoisomer III: 65°C	Tomlin 2003
Diastereoisomer IV: 106 °C	Tomlin 2003

Vapor Pressure

1.5×10^{-8} mm Hg at 25°C (**recommended value**)	Laskowski 2002
2.1×10^{-9} mm Hg at 20°C	Laskowski 2002
Diastereoisomer I: 9.6×10^{-4} mPa at 20°C	Tomlin 2003
Diastereoisomer II: 1.4×10^{-5} mPa at 20°C	Tomlin 2003
Diastereoisomer III: 2.1×10^{-5} mPa at 20°C	Tomlin 2003
Diastereoisomer IV: 8.5×10^{-5} mPa at 20°C	Tomlin 2003

Organic Carbon Sorption Partition Coefficients (log K_{oc})
5.09 average of 4 measurements with 4 different soils Laskowski 2002

Henry's constant (K_H)
3.7×10^{-6} atm m^3 mol^{-1} Laskowski 2002

Log K_{ow}
5.97 average of 4 measurements Laskowski 2002
6.4 calculated from molecular structure Laskowski 2002

pK_a
n/a

Environmental Fate

Table 1. Bioconcentration factors (BCFs) for cyfluthrin; FT: flow-through, S: Static.

Species	BCF	Exposure	Reference
Bluegill sunfish	719	FT	Laskowski 2002 (originally Carlisle & Roney 1984)
Bluegill sunfish	854 (max) 776 (mean)	FT	Carlisle & Roney 1984

Table 2. Cyfluthrin hydrolysis, photolysis, and biodegradation.

	Half- life (d)	Water	Temp (°C)	pH	Reference
Hydrolysis	Stable (0 d)	Buffered	25	5	Laskowski 2002
	183	Buffered	25	7	Laskowski 2002
	1.84	Buffered	25	9	Laskowski 2002
Aqueous Photolysis	0.673	Buffered	NR	NR	Laskowski 2002

4. Human and wildlife dietary values

There are no FDA action levels for cyfluthrin (USFDA 2000). There are no food tolerances for human consumption of fish, but there are food tolerances for cattle and hog meat at 0.1 ppm and goat, horse and sheep meat at 0.05 ppm (USEPA 2008).

Wildlife LC_{50}s (dietary) for animals with significant food sources in water

The 8-d dietary LC_{50} for 16-d old mallard ducks was determined to be > 5000 mg/kg feed (Carlisle & Toll 1983), although feeding and weight gain was substantially

reduced at 5000 ppm compared to the controls and those fed cyfluthrin at 2000 mg/kg feed.

Wildlife dietary NOECs for animals with significant food sources in water

A dietary NOEC of 250 mg/kg feed for 16-week old mallard ducks was determined over a 21 week period (Beavers 1986). A LOEC could not be determined in this study because no significant effects were observed at any concentration tested. The highest concentration of cyfluthrin in mallard feed was 250 mg/kg, which was reported as the NOEC for the study, but this is likely an underestimated value. A 24-week dietary exposure to 16-week old mallard ducks resulted in a NOEC of 250 mg/kg feed based on the reproductive endpoints of number of eggs laid, embryo survival and hatching, which were significantly affected at higher concentrations tested (Carlisle 1984c).

5. Ecotoxicity data

Approximately 53 original studies of the effects of cyfluthrin on aquatic life were identified and reviewed. In the review process, many parameters were rated for documentation and acceptability for each study, including, but not limited to: organism source and care, control description and response, chemical purity, concentrations tested, water quality conditions, and statistical methods (see Tables 3.6, 3.7, 3.8 in TenBrook *et al.* 2009a). Single-species effects studies that were rated relevant (R) or less relevant (L) according to the method (Table 3.6) were summarized in data summary sheets. Information in these summaries was used to evaluate each study for reliability using the rating systems described in the methodology (Tables 3.7 and 3.8, section 3-2.2, TenBrook *et al.* 2009a). Copies of completed summaries for all studies are included in Appendix A of this report. Cyfluthrin studies deemed irrelevant from an initial screening were not summarized (e.g., studies involving rodents or *in vitro* exposures). All data rated as acceptable (RR) or supplemental (RL, LR, LL) for criteria derivation are summarized in Tables 3 – 9, found at the end of this report. Acceptable studies rated as RR are used for numeric criteria derivation, while supplemental studies rated as RL, LR or LL are used for evaluation of the criteria to check that they are protective of particularly sensitive species and threatened and endangered species. These considerations are reviewed in sections 12 and 14 of this report, respectively. Studies that were rated not relevant (N) or not reliable (RN or LN) were not used for criteria derivation.

Using the data evaluation criteria (section 3-2.2, TenBrook *et al.* 2009a), 14 acute toxicity studies, yielding 32 toxicity values, were judged reliable and relevant (RR; Tables 3 and 4). Three chronic toxicity studies, yielding eleven toxicity values, were judged reliable and relevant (RR; Tables 6 and 7). Twelve acute and three chronic studies were rated RL, LL, or LR and were used as supplemental information for evaluation of the derived criteria in section 12 (Tables 5 and 9, respectively).

Eight mesocosm, microcosm and ecosystem (field and laboratory) studies were identified and reviewed. Six of these studies were rated R or L and were used as

supporting data in section 13 (Table 10). Three studies of cyfluthrin effects on wildlife were identified and reviewed for consideration of bioaccumulation in section 15.

6. Data reduction

Multiple toxicity values for cyfluthrin for the same species were reduced into one species mean acute toxicity value (SMAV) or one species mean chronic value (SMCV) according to procedures described in the methodology (section 3-2.4, TenBrook *et al.* 2009a). Acceptable acute and chronic data that were reduced, and the reasons for their exclusion, are shown in Tables 4 and 7, respectively. Reasons for reduction of data included: flow-through tests are preferred over static tests, more sensitive endpoints were available for the same test, and more appropriate or more sensitive test durations were available for the same test. The final acute and chronic data sets are shown in Tables 3 and 6, respectively. The final acute data set contains eight SMAVs, and the final chronic data set contains three SMCVs.

7. Acute criterion calculation

At least five acceptable acute toxicity values were available to fulfill the five taxa requirements of the species sensitivity distribution (SSD) procedure (section 3-3.1, TenBrook *et al.* 2009a). The five taxa requirements are a warm water fish, species in the family Salmonidae, a planktonic crustacean, a benthic crustacean, and an insect. The eight SMAVs in the acceptable data set (Table 3) were plotted in a histogram (Figure 2). The data do not appear to be bimodal, but the upper end of the distribution does appear to be absent from the data set. There were few data for very insensitive species available, such as mollusks, which would likely fall on the upper end of the distribution.

The log-logistic SSD procedure (section 3-3.2.2, TenBrook *et al.* 2009a) was used for the acute criterion calculation because there were not more than eight acceptable acute toxicity values available in the cyfluthrin data set (Table 2). The log-logistic SSD procedure was used to derive 5th percentile values (median and lower 95% confidence limit), as well as 1st percentile values (median and lower 95% confidence limit). The median 5th percentile value is recommended for use in criteria derivation by the methodology because it is the most robust of the distributional estimates (section 3-3.2, TenBrook *et al.* 2009a). Comparing the median estimate to the lower 95% confidence limit of the 5th percentile values, it can be seen that the first significant figures of the two values are different (0.00439 vs. 0.000147 µg/L). Because there is uncertainty in the first significant digit, the final criterion will be reported with one significant digit (section 3-3.2.6, TenBrook *et al.* 2009a).

The ETX 1.3 Software program (Aldenberg 1993) was used to fit the a log-logistic distribution to the data set, which is plotted with the acute values in Figure 3. This distribution provided a satisfactory fit (see Appendix A) according to the fit test described in section 3-3.2.4 of TenBrook *et al.* (2009a). No significant lack of fit was found ($\chi^2_{2n} = 0.2088$) using the fit test based on cross validation and Fisher's combined

test (section 3-3.2.4, TenBrook *et al.* 2009a), indicating that the data set is valid for criteria derivation.

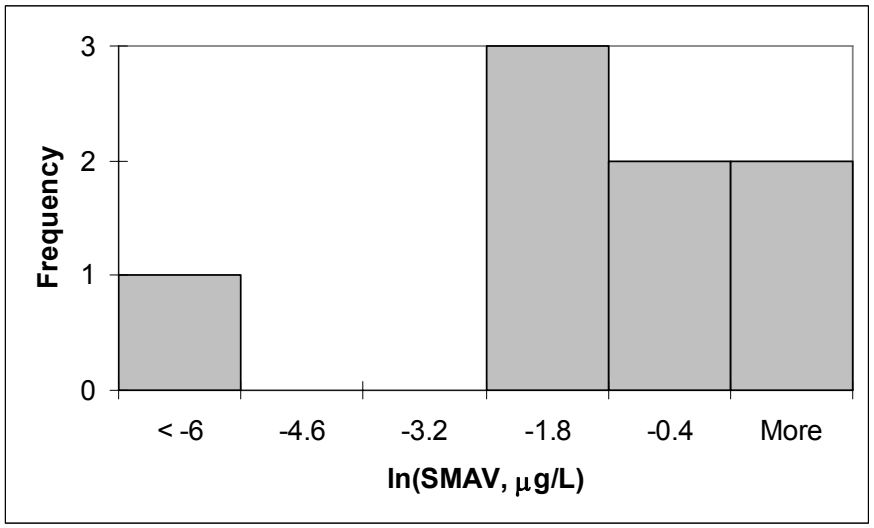

Figure 2. Histogram of acceptable acute cyfluthrin data.

Log-logistic distribution
HC5 Fitting Parameter Estimates: α = -0.7446, β (median) = 0.5478, β (lower 95% CI) = 1.04898.

5th percentile, 50% confidence limit: 0.00439 µg/L
5th percentile, 95% confidence limit: 0.000147 µg/L
1st percentile, 50% confidence limit: 0.000547 µg/L
1st percentile, 95% confidence limit: 0.0000027 µg/L

Recommended acute value = 0.00439 µg/L (median 5th percentile value)

Acute criterion = Recommended acute value ÷ 2
= 0.00439 µg/L ÷ 2
= 0.002195 µg/L

Acute criterion = 0.002 µg/L
= 2 ng/L

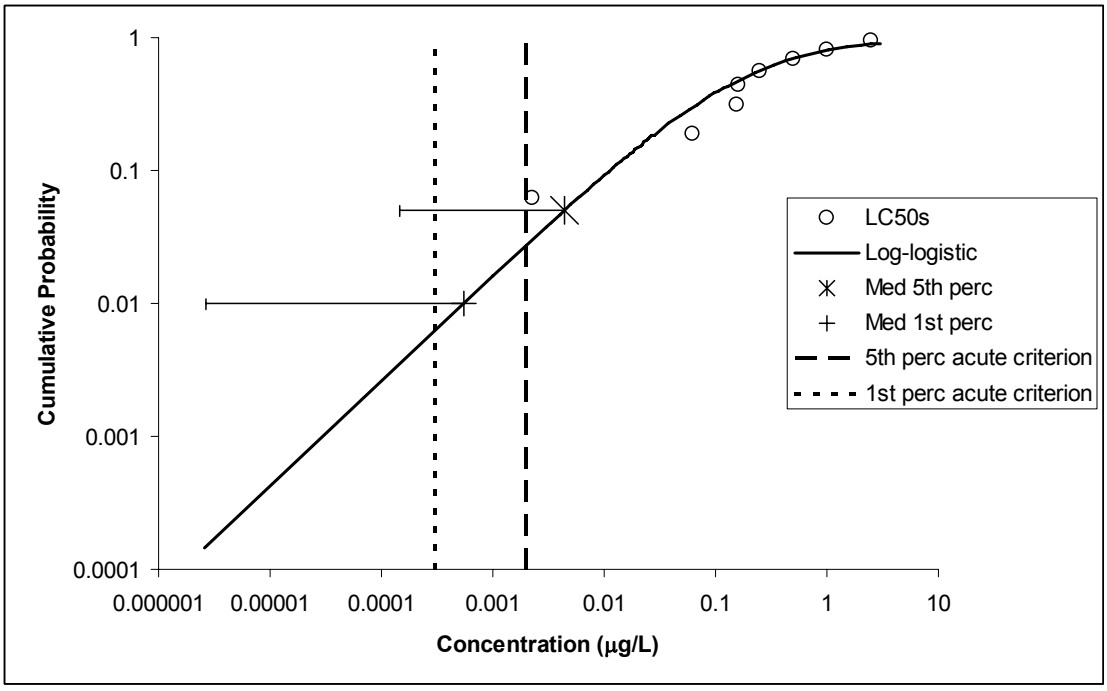

Figure 3. The fit of the log-logistic distribution to the acute data set. The median 5th percentile acute value and the median 1st percentile acute value are each displayed with their respective lower 95% confidence limit. The acute criteria calculated with the median 5th percentile value and the median 1st percentile value are each displayed as a vertical line for comparison.

8. Chronic criteria calculation

Chronic toxicity values from fewer than five different families were available, thus the acute-to-chronic ratio (ACR) method was used to calculate the chronic criterion (section 3-4.2, TenBrook *et al.* 2009a). Three chronic toxicity values are in the acceptable (rated RR) data set (Table 6) satisfying three of the five taxa requirements (section 3-3.1, TenBrook *et al.* 2009a): Salmonid (*Oncorhynchus mykiss*), warm water fish (*Pimephales promelas)* and planktonic crustacean (*Daphnia magna)*.

All three of the chronic toxicity values could be paired with an appropriate corresponding acute toxicity value in order to calculate an ACR, satisfying the three family requirements of the methodology: a fish, an invertebrate, and one more sensitive species (section 3-4.2.1, TenBrook *et al.* 2009a). The fathead minnow study by Rhodes *et al.* (1990) contained both acute and chronic values for calculation on an ACR, satisfying the recommendation that the acute and chronic tests be part of the same study and use the same dilution water (section 3-4.2.1, TenBrook *et al.* 2009a). The chronic rainbow trout and daphnid studies available did not contain acute values, but acute studies for these species were available that were appropriate for ACR derivation (section 3-4.2.1, TenBrook *et al.* 2009a). The acute and chronic *Daphnia magna* toxicity tests (Burgess 1990 and Forbis *et al.* 1984, respectively) were performed by the same lab with similar dilution waters. The acute *Oncorhynchus mykiss* data used to derive the ACR was

calculated as the geometric mean of the LC_{50} values from the studies Gagliano & Bowers 1994 and Bowers 1994 because they were both from the same laboratory with the same dilution waters. The chronic *Oncorhynchus mykiss* value was from a study by Carlisle (1985) from the same laboratory as the acute studies, and with very similar dilution water.

The ACRs were calculated for each of the three species by dividing the acute LC_{50} value by the chronic MATC value. The final multi-species ACR was obtained by calculating the geometric mean of the three ACR values because all species were within a factor of ten and there was not an increasing or decreasing trend in species mean ACR (SMACR) values with the species mean acute values (step 2, section 3-4.2.1, TenBrook *et al.* 2009a). The individual species and final multi-species ACR values generated are shown in Table 8.

The chronic criterion was calculated using the recommended acute value, which was the acute median 5th percentile value, and the final multi-species ACR value as follows:

Chronic criterion = recommended acute value ÷ ACR
= 0.00439 μg/L ÷ 10.27
= 0.000427 μg/L

Chronic criterion = 0.0004 μg/L
= 0.4 ng/L

9. Bioavailability

Although cyfluthrin and other pyrethroids are not very soluble in water, aquatic organisms are very sensitive to pyrethroids and toxicity does occur. Pyrethroids have been found as the cause of toxicity in surface waters in the California Central Valley (Phillips *et al.* 2007, Weston *et al.* 2009, Weston and Lydy 2010). This toxicity is believed to occur primarily from the fraction of the compound that is dissolved in the water, not from the compound that is associated with the particulate phase.

Several studies suggest that the binding of cyfluthrin and other pyrethroids to suspended solids and dissolved organic matter (DOM) will make the bound fraction unavailable and thus nontoxic to aquatic organisms. Yang *et al.* (2007) examined the uptake and acute toxicity of cyfluthrin by *Daphnia magna* and *Ceriodaphnia dubia* using natural water with various levels of DOM. These researchers found that low levels of DOM (3-20 mg/L) reduced cyfluthrin uptake by *D. magna* and acute toxicity to *C. dubia*. They did not find a direct correlation between the dissolved organic carbon (DOC) content of the DOM and uptake or toxicity, indicating that the quantity of DOC did not directly correlate with sorption, and that the quality, or characteristics, of the DOC and also affected uptake. Partition coefficients between water and DOC (K_{DOC}) ranged from 2.9 – 13.6 x 10^4 for cyfluthrin, indicating that partitioning is not solely dependent on the

amount of DOC and that site-specific K_{DOC} values would be ideal for estimation of cyfluthrin sorption to DOC. Yang *et al.* (2007) also report that the aqueous concentration of cyfluthrin measured by solid-phase microextraction (SPME) was correlated well with the variations in uptake and toxicity with different DOM, indicating that the SPME method of measurement correlates with bioavailability.

Xu *et al.* (2007) tested cyfluthrin toxicity to *Chironomus tentans* in 10-d sediment exposures with three types of sediment. The researchers reported cyfluthrin LC_{50} values for five phases: bulk sediment, OC-normalized sediment, bulk porewater, dissolved organic carbon (DOC)-normalized porewater, and the freely dissolved cyfluthrin. The LC_{50} values calculated for each of the five phases varied greatly, and varied between sediments for all phases tested except the freely dissolved, indicating that toxicity of the freely dissolved phase is independent of site-specific characteristics. The LC_{50} values based on the freely dissolved concentrations (0.0087-0.0089 μg/L) were more than an order of magnitude lower than those based on bulk porewater concentrations that included DOC (0.119-0.301 μg/L).

There are many studies on pyrethroids, not necessarily including cyfluthrin, that also demonstrate decreased toxicity of pyrethroids in the presence of sediment, DOC, and other natural sorbents (Day 1991; Smith and Lizotte 2007; Yang *et al.* 2006a, 2006b). These studies suggest that the freely dissolved concentration will be the most accurate predictor of toxicity and that bound cyfluthrin was unavailable to the studied organisms.

As a counterpoint, equilibrium partitioning would suggest that as organisms take up cyfluthrin, more cyfluthrin will desorb from particles, so the fraction absorbed to solids is likely not completely unavailable. According to the equilibrium partitioning model, cyfluthrin would continue to desorb from particles as organisms took it up, but the dissolved concentration would be constant if the system was at steady-state. This means that the duration of exposure could be increased, but not likely the magnitude. Benthic organisms, such as *Hyalella azteca,* may be at greater risk because of their exposure to porewater and close proximity to sediments.

Additionally, the role of dietary exposure on bioavailability of pyrethroids has not been extensively considered. Organisms living in contaminated waters may also be ingesting food with sorbed hydrophobic compounds that can be desorbed by digestive juices (Mayer *et al.* 2001). The effects of dietary exposure may also be species-specific, depending on typical food sources; some species may have greater interaction with particles, increasing their exposure. Palmquist *et al.* (2008) examined the effects due to dietary exposure of the pyrethroid esfenvalerate on three aqueous insects with different feeding functions: a grazing scraper (*Cinygmula reticulata* McDunnough), an omnivore filter feeder (*Brachycentrus americanus* Banks), and a predator (*Hesperoperla pacifica* Banks). The researchers observed adverse effects in *C. reticulata* and *B. americanus* after feeding on esfenvalerate-laced food sources and that none of the three insects avoided the contaminated food. The effects included reduced growth and egg production of *C. reticulata* and abandonment and mortality in *B. americanus*. These limited studies

indicate that ingestion may be an important exposure route, but it is not currently possible to incorporate this exposure route into criteria compliance assessment.

Section 3-5.1 of the methodology (TenBrook *et al.* 2009a) suggests that if studies indicate that fewer than three phases of the pesticide (sorbed to solids, sorbed to dissolved solids, or freely dissolved in the water) are bioavailable that compliance may be based on the concentration in the bioavailable phase(s). The studies above suggest that the freely dissolved fraction of cyfluthrin is the primary bioavailable phase, and that this concentration is the best indicator of toxicity, thus, it is recommended that the freely dissolved fraction of cyfluthrin be directly measured or calculated based on site-specific information for compliance assessment. Whole water concentrations are also valid for criteria compliance assessment, and may be used at the discretion of environmental managers, although the bioavailable fraction may be overestimated with this method.

The most direct way to determine compliance would be to measure the cyfluthrin concentration in the dissolved phase to determine the total bioavailable concentration. SPME has shown to be the best predictor of pyrethroid toxicity in several studies (Bondarenko *et al*. 2007, Bondarenko & Gan 2009, Hunter *et al.* 2008, Xu *et al.* 2007, Yang *et al.* 2006a, 2006b, 2007). Bondarenko & Gan (2009) report a method detection limit of 2.0 ng/L for cyfluthrin, although method detection limits vary between laboratories. Filtration of sediments is another option. Glass fiber filters with a nominal pore size of 0.7 μm or 0.45 μm are often used to remove the suspended sediments or both suspended sediments and dissolved organic matter, but the filters can interfere with the detection of hydrophobic contaminants. Gomez-Gutierrez *et al.* (2007) found that adsorption to filters was positively correlated with the log K_{ow} and solubility values of the compounds, and that on average 58% of the one pyrethroid tested (a 50 ng/L solution of permethrin) was lost on the filter. This loss may be critical for determining compliance at environmental concentrations.

Alternately, the following equation can be used to translate total cyfluthrin concentrations measured in whole water to the associated dissolved cyfluthrin concentrations:

$$C_{dissolved} = \frac{C_{total}}{1 + ((K_{OC} \cdot [SS]) / foc) + (K_{DOC} \cdot [DOC])} \quad (1)$$

where: $C_{dissolved}$ = concentration of chemical in dissolved phase (μg/L);
C_{total} = total concentration of chemical in water (μg/L);
K_{OC} = organic carbon-water partition coefficient (L/kg);
[*SS*] = concentration of suspended solids in water (kg/L);
f_{oc} = fraction of organic carbon in suspended sediment in water;
[*DOC*] = concentration of dissolved organic carbon in water (kg/L);
K_{DOC} = organic carbon-water partition coefficient (L/kg) for DOC.

To determine compliance by this calculation, site-specific data are necessary, including: K_{OC}, K_{DOC}, the concentration of suspended solids, the concentration of DOC, and the

fraction of organic carbon in the suspended solids. If all of these site-specific data, including the partition coefficients, are not available, then this equation should not be used for compliance determination. Site-specific data are required because the sorption of cyfluthrin to suspended solids and dissolved organic matter depends on the physical and chemical properties of the suspended solids resulting in a range of K_{OC} and K_{DOC} values, as discussed earlier in this section.

The freely dissolved cyfluthrin concentration is recommended for determination of criteria compliance because the literature suggests that the freely dissolved concentrations are the most accurate predictor of toxicity. Environmental managers may choose an appropriate method for determination of the concentration of freely dissolved cyfluthrin, or they may also choose to base compliance on whole water concentrations.

10. Mixtures

Cyfluthrin often occurs in the environment with other pyrethroid pesticides (Werner & Moran 2008). All pyrethroids have a similar mode of action, but some studies have indicated that pyrethroid mixture toxicities are not additive, and that slight antagonism can occur when pyrethroid mixture toxicity is tested. Definitions of additivity, synergism, antagonism, and non-additivity are available in the literature (Lydy and Austin 2004) and more detailed descriptions of mixture models can be found in the methodology (section 3-5.2, TenBrook *et al.* 2009a).

Brander *et al.* (2009) tested mixture toxicity of cyfluthrin and permethrin, and found slight antagonism for the binary mixture, but additivity was demonstrated when piperonyl butoxide (PBO) was added. Brander *et al.* (2009) offered several explanations for the observed antagonism between the two pyrethroids. Permethrin is a type I pyrethroid, and cyfluthrin is a type II pyrethroid, and type II pyrethroids might be able to outcompete type I pyrethroids for binding sites, which is known as competitive agonism; or binding sites may be saturated, so that complete additivity is not observed. They also note that cyfluthrin is metabolized more slowly than permethrin, so cyfluthrin can bind longer. PBO may remove this effect because the rate of metabolism of both pyrethroids is reduced in the presence of PBO. Barata *et al.* (2006) investigated the effects of binary mixtures on mortality and feeding in *Daphnia magna*; they observed slight antagonism in a lambda-cyhalothrin – deltamethrin mixture. The additivity of pyrethroid mixture toxicity has not been clearly defined in the literature, and in fact, antagonism has been observed, thus the concentration addition method is not recommended for use when multiple pyrethroids are found in a sample.

Piperonyl butoxide (PBO) is commonly added to pyrethroid insecticide treatments because it is known to increase the toxic effects of pyrethroids (Weston *et al.* 2006). Brausch and Smith (2009) tested toxicity of cyfluthrin alone and a combination of cyfluthrin and PBO with *Daphnia magna.* The LC_{50} of cyfluthrin alone (0.62 µg/L) was higher than that for cyfluthrin tested with a constant sublethal concentration of PBO (0.46 µg/L). An interaction coefficient of 1.35 can be calculated for *D. magna* with these values. Brander *et al.* (2009) observed *Hyalella azteca* LC_{50} values decreased by a factor

of 2 or 3.5 when a nonlethal concentration of PBO was mixed with cyfluthrin or permethrin, respectively. Because no multi-species interaction coefficients (K) are available to describe the synergism between cyfluthrin and PBO, there is no accurate way to account for this interaction in compliance determination. If more species are tested with mixtures of these two compounds and a multi-species interaction coefficient is determined, it should be incorporated into criteria compliance.

No studies on aquatic organisms were identified in the literature that could provide a quantitative means to consider mixtures of cyfluthrin with other classes of pesticides. Although there are examples of non-additive toxicity for cyfluthrin and other chemicals, a multispecies interaction coefficient is not available for any chemical with cyfluthrin, and therefore the concentrations of non-additive chemicals cannot be used for criteria compliance (section 3-5.2.2, TenBrook *et al.* 2009a).

11. Temperature, pH, other water quality effects

Temperature, pH, and other water quality effects on the toxicity of cyfluthrin were examined to determine if any effects are described well enough in the literature to incorporate into criteria compliance (section 3-5.3, TenBrook *et al.* 2009a). Temperature has been found to be inversely proportional to the aquatic toxicity and bioavailability of pyrethroids (Miller & Salgado 1985, Werner & Moran 2008). In fact, the increase of toxicity of pyrethroids with decreasing temperature has been used to implicate pyrethroids as the source of toxicity in environmental samples (Phillips *et al.* 2004). The inverse relationship between temperature and pyrethroid toxicity is likely due to the increased sensitivity of an organism's sodium channels at low temperatures (Narahashi *et al.* 1998).

Enhanced toxicity of cyfluthrin to larval fathead minnows (*Pimephales promelas*) at lower temperatures was demonstrated by Heath *et al.* (1994). Sublethal cyfluthrin concentrations reduced the ability of fish to tolerate temperatures both higher and lower than standard conditions. The toxicities of six aqueous pyrethroids, not including cyfluthrin, were 1.33- to 3.63-fold greater at 20˚C compared to 30˚C for mosquito larvae (Cutkomp and Subramanyam 1986). The enhanced toxic effects of pyrethroids at lower temperatures may not be accurately represented by the results of typical laboratory toxicity tests, which tend to be run at warmer temperatures, 20-23 ˚C (USEPA 1996a, USEPA 1996b, USEPA 2000), than those of the habitats of coldwater fishes, about 15 ˚C or lower (Sullivan *et al.* 2000).

The toxicity of sediments contaminated with pyrethroids (including cyfluthrin) was more than twice as toxic when tested at 18˚C compared to 23˚C (Weston *et al.* 2008). Weston *et al.* (2008) used a toxicity identification evaluation (TIE) procedure to determine the effect of temperature reduction (18 vs. 23˚C) on toxicity of a particular environmental sediment sample to *Hyalella azteca*. These results are not directly applicable for use in water quality criteria compliance because they were sediment exposures, and used environmental samples, instead of an exposure to a pure compound. In studies that used topical exposures (more relevant to spray application exposure to

target a pest), the difference in toxicity can increase by a factor of about 1.5 to a factor of 10, in the temperature range of about 10 to 27 ˚C (Kumaraguru & Beamish 1981; Punzo 1993; Schnitzerling 1985).

Unfortunately, there are limited data demonstrating increased toxicity at lower temperatures using aquatic exposures with relevant species, making it unfeasible to quantify the relationship between the toxicity of cyfluthrin and temperature for water quality criteria at this time (section 3-5.3, TenBrook *et al.* 2009a). Several studies that examined the effects of DOC and DOM concentrations are discussed in the bioavailability section 9 above. No other studies on cyfluthrin were identified that examined the effects of pH or other water quality parameters on toxicity, thus, there is no way to incorporate any of these parameters into criteria compliance.

12. Sensitive species

The derived criteria are compared to toxicity values for the most sensitive species in both the acceptable (RR) and supplemental (RL, LR, LL) data sets to ensure that these species will be adequately protected (section 3-6.1, TenBrook *et al.* 2009a). The lowest SMAV in the data sets rated RR, RL, LR, or LL (Tables 3 - 5) is 2.3 ng/L for the amphipod *Hyalella azteca,* and the lowest individual toxicity value in the data sets is 1.7 ng/L for *H. azteca* (Weston & Jackson 2009). The derived acute criterion of 2 ng/L does not appear to be protective of *Hyalella azteca*, the most sensitive species in the data set. The acute derived criterion of 2 ng/L is almost equivalent to the *H. azteca* SMAV of 2.3 ng/L, and the data set contains a LC_{50} for this species at 1.7 ng/L, below the derived criterion. We recommend the use of the median 1st percentile estimate to derive the acute criterion, in order to be protective of this sensitive species. The acute criterion is calculated as follows:

Recommended acute value = 0.000547 µg/L (median 1st percentile value)

Acute criterion = Recommended acute value ÷ 2
= 0.000547 µg/L ÷ 2
= 0.000274 µg/L

Acute criterion = 0.0003 µg/L
= 0.3 ng/L

The ACR method for chronic criterion calculation uses the recommended acute value (section 3-4.2, TenBrook *et al.* 2009), thus, the chronic criterion will be re-calculated with the median 1st percentile value as follows:

Chronic criterion = recommended acute value ÷ ACR
= 0.000547 µg/L ÷ 10.27
= 0.0000533 µg/L

Chronic criterion = 0.00005 µg/L

= 0.05 ng/L

The recommended chronic criterion (0.05 ng/L) is below the lowest SMCV in the data set rated RR (Tables 6 and 7), which is a MATC of 13.3 ng/L for *Oncorhynchus mykiss*, and below the lowest chronic value in the data set rated RL, LR, or LL (Table 8), which is a MATC of 0.27 ng/L for *Americamysis bahia* (formerly *Mysidopsis bahia*), a saltwater species. There are no chronic data available for the most sensitive species in the acute data set, which are both benthic crustaceans: *Hyalella azteca* and *Procambarus clarkii.* The recommended chronic criterion (0.05 ng/L) is below the MATC for *Americamysis bahia*, which has a similar acute toxicity value to *Hyalella azteca* (2.46 vs. 2.3 ng/L). Although this does not compensate for the lack of data for sensitive freshwater species, it is an indication that the recommended chronic criterion will likely be protective of sensitive species.

13. Ecosystem and other studies

The derived criteria are compared to acceptable laboratory, field, or semi-field multispecies studies (rated R or L) to determine if the criteria will be protective of ecosystems (section 3-6.2, TenBrook *et al.* 2009a). Eight mesocosm, microcosm or ecosystem (field and laboratory) studies were identified and rated for reliability according to the methodology (Table 3.9, TenBrook *et al.* 2009a). Five of the studies were rated as reliable (R; Gunther & Herrmann 1986, Morris 1991, Johnson 1992, Johnson *et al.* 1994, Kennedy *et al.* 1990), and one was rated less reliable (L; Morris *et al.* 1994). All of the studies rated R or L are listed in Table 10. Two studies rated as not reliable (N) and are not discussed in this report (Graney & Gagliano 1993, Heimbach & Pflueger 1992). These studies were primarily outdoor microcosms and mesocosms mimicking small pond environments and all exposures used commercial formulations of cyfluthrin. Unfortunately, none of the studies report a community NOEC to which the calculated criteria may be compared.

Gunther & Herrmann (1986) observed trout, macroinvertebrates, macrobenthos, zooplankton, and phytoplankton in natural earth ponds that were part of a commercial trout and carp farm in Germany after a single treatment of a cyfluthrin formulation at the recommended rate, and five times above that rate (0.22 and 1.77 µg/L, respectively). Large numbers of invertebrates died within the first few hours, and were seen congregating on the surface shortly after the initial cyfluthrin application. Other biological effects observed included a decrease in the population density of water mites and a depression of the crustacean population lasting for 1-2 weeks after treatment

Several studies reported results from experiments that compared bluegill and invertebrate populations in concrete microcosms and earthen mesocosms treated with cyfluthrin (Morris 1991, Morris *et al.* 1994, Johnson 1992, Johnson *et al.* 1994). Johnson (1992) and Johnson *et al.* (1994) appear to report data from the same study. They reported that biological effects due to cyfluthrin were similar in both systems: cladocerans, mayflies, Tanypodinae chironomids, and *Chaoborus* populations were reduced, while oligochaetes, rotifers, gastropods, odonates, Ceratopogonidae and

Chironiminae Chironomids were not affected or increased. The abundance of many Cladoceran and macroinvertebrate species was reduced at the lowest of four doses tested; the author reports that the lowest dose is the LOEC, and that a NOEC could not be calculated because it is below the lowest dose tested. The measured concentrations of the lowest dose over a 10 week period ranged from 0-200 ng/L. Measured cyfluthrin concentrations of all four doses ranged from 0-1.0 μg/L. Johnson (1992) also conducted several single-species bioassays and found that the results of these tests correlated very well with the levels of effects observed in the microcosm, indicating that single-species tests are good approximations of ecosystem-level tests, and vice versa. Morris *et al.* (1994) reported a slight, but statistically significant, decrease in bluegill growth was observed in the microcosm study, and was likely due to reduced prey populations after cyfluthrin treatments (measured concentrations ranged from 0.027-0.145 μg/L).

Kennedy *et al.* (1990) examined the effects of cyfluthrin applied either as a surface spray or as a soil-water slurry on mesocosms containing phytoplankton, zooplankton, macroinvertebrates, and bluegills. Whole water concentrations measured in the spray drift ponds and slurry ponds ranged from 0.028-0.216 μg/L and 0.079-0.687 μg/L, respectively. Effects observed due to cyfluthrin treatment include: reduced turbidity in treated ponds, reduced crustaceans, increased Rotifera populations, decline in some macroinvertebrate groups (Gammarids, Coleoptera, Hemiptera). No effects were observed in bluegill mortality or reproduction.

Very few of these studies applied or measured concentrations near the derived cyfluthrin criteria, most tested concentrations were far above the derived criteria. All of these studies did observe adverse effects due to cyfluthrin applications, especially on aquatic macroinvertebrates. It is not possible to assess if effects would have occurred at lower cyfluthrin concentrations, but the recommended chronic criterion of 0.05 ng/L is well below the measured cyfluthrin concentrations reported in these studies, and therefore should be protective of the organisms found in these studies.

14. Threatened and endangered species

The derived criteria are compared to measured toxicity values for threatened and endangered species (TES), as well as to predicted toxicity values for TES, to ensure that they will be protective of these species (section 3-6.3, TenBrook *et al.* 2009a). Current lists of state and federally listed threatened and endangered plant and animal species in California were obtained from the California Department of Fish and Game (CDFG) website (http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf; CDFG 2008). One listed animal species is represented in the data set. Five Evolutionarily Significant Units of *Oncorhynchus mykiss* are listed as federally threatened or endangered throughout California. The acute data set includes a SMAV for *O. mykiss* of 0.119 μg/L calculated from three studies rated RR. The chronic data set includes a SMCV for *O. mykiss* of 0.0133 μg/L calculated for two endpoints in one study rated RR. Both of these values in the data sets were included in the criteria calculations and are well above the recommended criteria (0.0003 and 0.00005 μg/L).

Some of the listed species are represented in the acute toxicity data set by members of the same family or genus. *Oncorhynchus mykiss* can serve as a surrogate in estimates for other species in the same family using the USEPA interspecies correlation estimation website (WEB-ICE v. 2.0; Raimondo *et al.* 2007). Unfortunately, the LC_{50} of *O. mykiss* (0.1192 µg/L) was below the model minimum input toxicity value of 0.163 µg/L, so toxicity values could not be estimated for species in the Salmonidae family.

No single-species plant studies were found in the literature for use in criteria derivation, so no estimation could be made for plants on the state or federal endangered, threatened or rare species lists. There are also no aquatic plants listed as state or federal endangered, threatened or rare species so they are not considered in this section.

15. Bioaccumulation

Bioaccumulation was assessed to ensure that the derived criteria will not lead to unacceptable levels of cyfluthrin in food items (section 3-7.1, TenBrook *et al.* 2009a). Cyfluthrin has a log K_{ow} of 5.97 and a molecular weight of 434.3 (section 3), which indicates its bioaccumulative potential (section 3-7.1, TenBrook *et al.* 2009a). No biomagnification factor (BMF) values were found in the literature for cyfluthrin. Bioconcentration of cyfluthrin has been measured in several studies (Table 1), which are briefly summarized here. The bioconcentration factor (BCF) in bluegill sunfish (*Lepomis macrochirus*) was a maximum BCF of 854 and a mean BCF of 776 (Carlisle & Roney 1984). The BCF value for bluegill sunfish reported in a review article by Laskowski (2002) was similar at 719. Wild-caught brown trout (*Salmo trutta*), captured in a British stream, were found to have accumulated cyfluthrin of 25.4 µg/kg, and as high as 109 µg/kg in tissues, even though no cyfluthrin could be detected in the water column (Bonwick *et al.* 1996).

To check that these criteria are protective of terrestrial wildlife that may consume aquatic organisms, a bioaccumulation factor (BAF) was used to estimate the water concentration that would roughly equate to a reported toxicity value for consumption of fish by terrestrial wildlife. These calculations are further explained in section 3-7.1 of the methodology (TenBrook *et al.* 2009a). The BAF of a given chemical is the product of the BCF and a BMF, such that BAF=BCF*BMF. For a conservative estimate, the BCF value of 854 L/kg for *Lepomis macrochirus* was used (Table 1). A default BMF value of 10 was chosen based on the log K_{ow} of cyfluthrin (Table 3.15, TenBrook *et al.* 2009a). An oral predator dietary NOEC value for mallard duck of 250 mg/kg feed (Carlisle 1984c) was used in the calculation because it was the most sensitive dietary toxicity value reported for mallard.

$$NOEC_{water} = \frac{NOEC_{oral\_predator}}{BCF_{food\_item} * BMF_{food\_item}} \qquad (2)$$

Mallard: $$NOEC_{water} = \frac{250\,^{mg}/_{kg}}{854\,^{L}/_{kg} * 10} = 0.029\,^{mg}/_{L} = 29\,^{\mu g}/_{L}$$

In this example, the calculated chronic criterion approximately five orders of magnitude below the estimated $NOEC_{water}$ value for the mallard and adverse effects due to bioaccumulation are not expected. The mallard $NOEC_{water}$ is actually above the water solubility of cyfluthrin (2.3 μg/L), and therefore, would not occur in an aqueous environment.

To check that these criteria are protective of humans that may consume aquatic organisms, a BAF will be used to estimate the water concentration that would roughly equate to a limit for human food consumption. An appropriate BAF was not available in the data set. The BCF value for bluegill sunfish of 854 (Carlisle & Roney 1984, Table 1) and a default BMF are used to approximate a BAF. There are no tolerance or FDA action levels for fish tissue (USFDA 2000), but there is a food tolerance for cattle and hog meat at 0.1 ppm and goat, sheep, and horse meat at 0.05 ppm (USEPA 2008). These values can be used to roughly estimate if bioconcentration could cause cyfluthrin concentrations in fish tissues to be of concern to human health.

Human: $$NOEC_{water} = \frac{0.05\,^{mg}/_{kg}}{854\,^{L}/_{kg} * 10} = 0.00000585\,^{mg}/_{L} = 0.00585\,^{\mu g}/_{L} = 6\,^{ng}/_{L}$$

In this example, the derived chronic criterion of 0.05 ng/L is approximately two orders of magnitude below the estimated water concentrations of concern for humans. The human $NOEC_{water}$ would likely cause toxicity to aquatic organisms if such an excursion were to occur. Adhering to the derived cyfluthrin criteria should also prevent bioaccumulative exposure to terrestrial wildlife and humans.

16. Harmonization/coherence across media

This section addresses how the maximum allowable concentration of cyfluthrin might impact life in other environmental compartments through partitioning (section 3-7.2, TenBrook *et al.* 2009a). However, there are no federal or state sediment or air quality standards for cyfluthrin (CARB 2005, CDWR 1995, USEPA 2006a, b) to enable this kind of extrapolation. For biota, the limited data on bioconcentration or biomagnification of cyfluthrin was addressed in the bioaccumulation section (section 15).

17. Assumptions, Limitations and Uncertainties

The assumptions, limitations and uncertainties involved in criteria derivation should be available to inform environmental managers of the accuracy and confidence in the derived criteria (section 3-8.0, TenBrook *et al.* 2009a). Chapter 2 of the methodology discusses these points for each section as different procedures were chosen, such as the list of assumptions associated with using a SSD (section 2-3.1.5.1), and there is a review of the assumptions in section 2-7.0 (TenBrook *et al.* 2009a). This section summarizes any

data limitations that affected the procedure used to determine the final cyfluthrin criteria. The different calculations of distributional estimates included in section 7 of this report may be used to consider the uncertainty in the resulting acute criterion.

There was enough highly rated acute cyfluthrin data to use a SSD to calculate the acute criterion, but one limitation in the data set is that not all of the data are from flow-through tests that use measured concentrations to calculate the toxicity values. Flow-through tests and measurement of concentrations is particularly important in tests with pyrethroid pesticides because they are highly sorptive. Five of the eight acute RR data are from flow-through tests with measured concentrations, but the lowest value in the data set (*Hyalella azteca* SMAV=2.3 ng/L) is from a static renewal test calculated with estimated concentrations, and could be underestimated.

For cyfluthrin, the major limitation was in the chronic toxicity data set. Two of five taxa requirements were not met for the chronic data set (benthic crustacean and insect), which precluded the use of a SSD; therefore, an ACR was used to derive the chronic criterion. There was measured data available for calculation of a multi-species ACR (as specified in section 3-4.2.1, TenBrook *et al.* 2009a). Particularly of concern for the chronic toxicity data set was the lack of data on *Hyalella azteca* or another benthic organism, which was the most sensitive species in the acute toxicity data set. Uncertainty cannot be quantified for the chronic criterion because it was derived using an ACR, not an SSD.

Another concern that could not be accounted for quantitatively for criteria compliance is the increase in toxicity from lower temperatures. All of the toxicity data were from tests performed at standard temperature, usually around 20 ˚C, except for rainbow trout (*Oncorhynchus mykiss*). However, many streams in the California Central Valley often have lower water temperatures. If colder water bodies are impacted by concentrations of cyfluthrin, it may be appropriate to apply an additional safety factor to the cyfluthrin criteria for those areas, to ensure adequate protection. A rough factor of two could be estimated from a study by Weston *et al.* (2008), however, a study relating temperature to aqueous toxicity of cyfluthrin in multiple species, including *Hyalella azteca,* would be ideal to derive such an adjustment factor. We do not recommend an additional safety factor to account for temperature effects at this time, but environmental managers may want to consider this application if the criteria do not appear to be protective of organisms in a colder water body. If aquatic exposure data for multiple species demonstrating temperature effects becomes available in the future, a regression equation describing the effect should be incorporated into criteria compliance.

Although greater than additive effects have been observed for mixtures of pyrethroids and PBO, there is insufficient data to account for this interaction for compliance determination. This is a significant limitation because formulations that contain both pyrethroids and PBO are now available on the market. When additional highly rated data is available, the criteria should be recalculated to incorporate new research.

18. Comparison to National Standard Methods

This section is provided as a comparison between the new methodology for criteria calculation (TenBrook *et al.* 2009a) and the current USEPA (1985) national standard. The cyfluthrin data set generated in this report was examined for use with the USEPA 1985 methodology.

The USEPA acute methods have three additional taxa requirements beyond the five required by the methodology used in this criteria report (section 3-3.1, TenBrook *et al.* 2009a). They are:

1. A third family in the phylum Chordata (e.g., fish, amphibian);
2. A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca);
3. A family in any order of insect or any phylum not already represented.

One out of three of these additional requirements are met as follows:

1. The other fish/amphibian requirement is met with data from the fathead minnow (*Pimephales promelas*).
2. This requirement is not met because all data are from organisms in the phylum Arthropoda or Chordata.
3. This requirement is not met because there are no insect data and no data for other phyla not already represented.

The USEPA methodology cannot be used to calculate an acute criterion for cyfluthrin because two of the eight taxa requirements are not met. CDFG have used data sets that met only seven of eight requirements in the USEPA methodology, but have not used data sets that only met six of eight requirements. An acute criterion will not be calculated using the USEPA 1985 methodology.

The chronic data set is also deficient, only meeting three of the eight taxa requirements of the USEPA 1985 methodology, which are the same three met in the methodology used by this report and discussed in section 8.

19. Final criteria statement

The final criteria statement is:

Aquatic life in the Sacramento River and San Joaquin River basins should not be affected unacceptably if the four-day average concentration of cyfluthrin does not exceed 0.00005 µg/L (0.05 ng/L) more than once every three years on the average and if the one-hour average concentration does not exceed 0.0003 µg/L (0.3 ng/L) more than once every three years on the average.

Although the criteria were derived to be protective of aquatic life in the Sacramento and San Joaquin Rivers, these criteria would be appropriate for any freshwater ecosystem in North America, unless species more sensitive than are represented by the species examined in the development of these criteria are likely to occur in those ecosystems.

The final acute criterion was derived using the log-logistic SSD procedure (section 9) and the acute data used in criteria calculation are shown in Table 3. The chronic criterion was derived by use of an ACR calculated from measured data (section 10); chronic data rated RR are shown in Table 6, and the ACRs are shown in Table 8. The criteria were initially calculated with the median 5th percentile estimate of the distribution, but comparison of the criteria with sensitive species in the data set indicated that the criteria should be adjusted downward (section 12). The final criteria were calculated with the median 1st percentile estimates of the distribution.

To date, there are no established criteria for cyfluthrin to which the criteria calculated in this report can be compared. Solomon *et al.* (2001) performed a probabilistic risk assessment with pyrethroids. Saltwater and freshwater toxicity data were combined so the lowest acute and chronic toxicity values in the data set were 2.42 ng/L and 0.17 ng/L, respectively (for mysid, a saltwater species). The 5th percentile value for cyfluthrin, based on a log-normal distribution, was < 4 ng/L, although much of the author's discussion centered on the 10th percentile as the protective limit, which was 12 ng/L for cyfluthrin when insensitive algal data were omitted.

The derived criteria appear to be protective considering bioaccumulation, ecosystem level toxicity and threatened and endangered species as discussed above in the report, but the criteria calculations should be updated whenever new data is available.

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Data Tables

Table 3. Final acute toxicity data set for cyfluthrin. All studies were rated RR and were conducted at standard temperature. S: static; SR: static renewal; FT: flow-through, 95% CI: 95% confidence interval.

Species	Common Identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference
Aedes aegypti Rockefellar	Mosquito	Culicidae	S	Nom	93.0%	24 h	25	Mortality	early 4th instar larvae	1 (1-2)	Rodriguez et al. 2007
Aedes aegypti Nicaragua	Mosquito	Culicidae	S	Nom	93.0%	24 h	25	Mortality	early 4th instar larvae	0.5 (0.5-0.6)	Rodriguez et al. 2007
Aedes aegypti Peru	Mosquito	Culicidae	S	Nom	93.0%	24 h	25	Mortality	early 4th instar larvae	0.3 (0.1-0.4)	Rodriguez et al. 2007
geomean										**0.5**	
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	97.0%	48 h	25	Mortality	< 24 h	0.344 ± 0.041	Wheelock *et al.* 2004
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.093 (0.050-0.146)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.136 (0.103-0.185)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.189 (0.112-0.292)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.134 (0.097-0.194)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.170 (0.121-0.229)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.145 (0.105-0.185)	Yang et al. 2007

Species	Common Identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.102 (0.027-0.395)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.159 (0.105-0.234)	Yang et al. 2007
Ceriodaphnia dubia	Daphnid	Daphniidae	S	Nom	99.0%	96 h	21	Mortality	< 24 h	0.180 (0.127-0.280)	Yang et al. 2007
geomean										**0.155**	
Daphnia magna	Daphnid	Daphniidae	FT	Meas	98.6%	48 h	19	Mortality	< 24 h (1st instar)	**0.16** (0.14-0.18)	Burgess 1990
Hyalella azteca	Amphipod	Hyalellidae	SR	Est	98.0%	96 h	23	Mortality	7-14 d	0.0017 (0.0011-0.0023)	Weston & Jackson 2009
Hyalella azteca	Amphipod	Hyalellidae	SR	Est	98.0%	96 h	23	Mortality	7-14 d	0.0023 (0.0009-0.0028)	Weston & Jackson 2009
Hyalella azteca	Amphipod	Hyalellidae	SR	Est	98.0%	96 h	23	Mortality	7-14 d	0.0031 (0.0021-0.0046)	Weston & Jackson 2009
geomean										**0.0023**	
Lepomis macrochirus	Bluegill sunfish	Centrarchidae	FT	Meas	97.6%	96 h	22	Mortality	0.82 g, 31.8 mm	**0.998**	Gagliano 1994 MRID 45426707
Oncorhynchus mykiss	Rainbow trout	Salmonidae	FT	Meas	97.6%	96 h	11	Mortality	0.92 g, 39 mm	0.209	Gagliano & Bowers 1994 MRID 45426708
Oncorhynchus mykiss	Rainbow trout	Salmonidae	FT	Meas	97.6%	96 h	12	Mortality	1.4 g, 43.3 mm	0.302 (0.240-0.432)	Bowers 1994 MRID 45426705

Species	Common Identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference
geomean										**0.2512**	
Pimephales promelas	Fathead minnow	Cyprinidae	FT	Meas	99.0%	96 h	25	Mortality	30 d old	**2.49**	Rhodes et al. 1990
Procambarus clarkii	Crayfish	Cambaridae	FT	Meas	97.0%	96 h	20	Mortality	0.59 g, 29 mm	**0.062**	Surprenant 1990

Table 4. Reduced acute data rated RR with given reason for exclusion. S: static; SR: static renewal; FT: flow-through.

Species	Common Identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference	Reason
Daphnia magna	Daphnid	S	Nom	87.0%	48 h	19	Mortality	< 24 h (1st instar)	0.141	Carlisle & Carsel 1983b	B
Daphnia magna	Daphnid	S	Nom	94.1%	48 h	20	Mortality	< 24 h (1st instar)	2.7 (1.4-4.7)	Heimbach 1984a	B
Lepomis macrochirus	Bluegill sunfish	FT	Meas	97.6%	72 h	22	Mortality	0.82 g, 31.8 mm	1.024	Gagliano 1994 MRID 45426707	A
Lepomis macrochirus	Bluegill sunfish	S	Nom	87.0%	96 h	20	Mortality	0.8 g	1.5	Carlisle & Roney 1983	B
Oncorhynchus mykiss	Rainbow trout	S	Nom	87.0%	96 h	13	Mortality	0.3 g	0.68	Carlisle & Carsel 1983a	B
Oncorhynchus mykiss	Rainbow trout	S	Nom	87.0%	96 h	12	Mortality	2.3-2.6 g	2.9 (2.5-3.3)	Carlisle 1984b	B
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	48 h	11	Mortality	0.92 g, 39 mm	0.309	Gagliano & Bowers 1994 MRID 45426708	A
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	72 h	11	Mortality	0.92 g, 39 mm	0.251	Gagliano & Bowers 1994 MRID 45426708	A
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	48 h	12	Mortality	1.4 g, 43.3 mm	0.497 (0.432-0.642)	Bowers 1994 MRID 45426705	A
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	72 h	12	Mortality	1.4 g, 43.3 mm	0.352 (0.240-0.432)	Bowers 1994 MRID 45426705	A

Reasons for Exclusion

A. Not the most sensitive or appropriate duration
B. FT test preferred over S

Table 5. Supplemental acute data rated RL, LR, and LL with rating and reason for exclusion given below. S: static; SR: static renewal; FT: flow-through. NR: not reported.

Species	Common Identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference	Rating/ Reason
Crassostrea virginica	Eastern oyster	FT	Meas	95.2%	96 h	21	Shell deposition	2-4 cm prespawn	3.42 (2.99-3.95)	Carr 1986b	LR 2
Crassostrea virginica	Eastern oyster	S	Nom	87.0%	96 h	21	Shell deposition	41.2 mm	5	Barrows 1984b	LR 2
Cyprinodon variegatus	Sheepshead minnow	S	Nom	87.0%	24 h	20	Mortality	0.55g, 23.5 mm	4.40 (3.6-6.0)	Barrows 1984a	LR 2
Cyprinodon variegatus	Sheepshead minnow	S	Nom	87.0%	48 h	20	Mortality	0.55g, 23.5 mm	4.40 (3.6-6.0)	Barrows 1984a	LR 2
Cyprinodon variegatus	Sheepshead minnow	S	Nom	87.0%	72 h	20	Mortality	0.55g, 23.5 mm	4.05 (2.16-6)	Barrows 1984a	LR 2
Cyprinodon variegatus	Sheepshead minnow	S	Nom	87.0%	96 h	20	Mortality	0.55g, 23.5 mm	4.05 (2.16-6)	Barrows 1984a	LR 2
Daphnia magna	Daphnid	S	Nom	11.8%	48 h	25	Mortality	< 24 h	0.62	Brausch & Smith 20089	LR 5
Lepomis macrochirus	Bluegill sunfish	FT	Meas	97.6%	24 h	22	Mortality	0.82 g, 31.8 mm	$\geq$ 1.5	Gagliano 1994 MRID 45426707	LR 6
Lepomis macrochirus	Bluegill sunfish	FT	Meas	97.6%	48 h	22	Mortality	0.82 g, 31.8 mm	$\geq$ 1.15	Gagliano 1994 MRID 45426707	LR 6
Mysidopsis bahia	Mysid shrimp	FT	Meas	90.5%	24 h	22-28	Mortality	6 d old	0.0202 (0.0163-0.0258)	Johnson et al. 1985	LR 1, 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	90.5%	48 h	22-28	Mortality	6 d old	0.00804 (0.00616-0.0108)	Johnson et al. 1985	LR 1, 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	90.5%	72 h	22-28	Mortality	6 d old	0.00761 (0.00582-0.0102)	Johnson et al. 1985	LR 1, 2

Species	Common Identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference	Rating/ Reason
Mysidopsis bahia	Mysid shrimp	FT	Meas	90.5%	96 h	22-28	Mortality	6 d old	0.00637 (0.00463-0.00878)	Johnson et al. 1985	LR 1, 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	97.4%	24 h	25	Mortality	< 24 h	0.00608 (0.00468-0.01235)	Surprenant 1987	LR 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	97.4%	48 h	25	Mortality	< 24 h	0.00384 (0.00318-0.00493)	Surprenant 1987	LR 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	97.4%	72 h	25	Mortality	< 24 h	0.00334 (0.00273-0.00426)	Surprenant 1987	LR 2
Mysidopsis bahia	Mysid shrimp	FT	Meas	97.4%	96 h	25	Mortality	< 24 h	0.00246 (0.00196-0.00326)	Surprenant 1987	LR 2
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	24 h	11	Mortality	0.92 g, 39 mm	≥ 0.699	Gagliano & Bowers 1994 MRID 45426708	LR 6
Oncorhynchus mykiss	Rainbow trout	FT	Meas	97.6%	24 h	12	Mortality	1.4 g, 43.3 mm	≥ 0.642	Bowers 1994 MRID 45426705	LR 6
Procambarus clarkii	Crayfish	FT	Meas	97.0%	24 h	20	Mortality	0.59 g, 29 mm	>0.079	Surprenant 1990	LR 6
Procambarus clarkii	Crayfish	FT	Meas	97.0%	48 h	20	Mortality	0.59 g, 29 mm	>0.079	Surprenant 1990	LR 6
Procambarus clarkii	Crayfish	FT	Meas	97.0%	72 h	20	Mortality	0.59 g, 29 mm	>0.079	Surprenant 1990	LR 6

Reasons for Exclusion

1. Not a standard method
2. Saltwater
3. Unacceptable control response
4. Low reliability score

Species	Common Identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L) (95% CI)	Reference	Rating/ Reason

5. Low chemical purity
6. Toxicity value not calculable

Table 6. Final chronic toxicity data set for cyfluthrin. All studies were rated RR. S: static; SR: static renewal; FT: flow-through. NR: not reported.

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference
Daphnia magna	Daphnid	FT	Meas	94.7%	21 d	20	Reproduction (young/female/d)	< 24 h	0.020	0.041	0.02864	Forbis et al. 1984
Daphnia magna	Daphnid	FT	Meas	94.7%	21 d	20	Length	< 24 h	0.020	0.041	0.02864	Forbis et al. 1984
geomean											**0.02864**	
Oncorhynchus mykiss	Rainbow trout	FT	Meas	96.0%	58 d	9.4	Biomass/ chamber	eggs	0.01	0.0177	0.0133	Carlisle 1985
Oncorhynchus mykiss	Rainbow trout	FT	Meas	96.0%	58 d	9.4	Mean weight/fish	eggs	0.01	0.0177	0.0133	Carlisle 1985
geomean											**0.0133**	
Pimephales promelas	Fathead minnow	FT	Meas	99.0%	7-61 d	25	F0 Survival	eggs	0.14	0.29	0.20	Rhodes et al. 1990
Pimephales promelas	Fathead minnow	FT	Meas	99.0%	61-120 d	25	F0 Survival	eggs	0.14	0.29	0.20	Rhodes et al. 1990
Pimephales promelas	Fathead minnow	FT	Meas	99.0%	90 d	25	F1 % Hatch	eggs	0.14	0.29	0.20	Rhodes et al. 1990
Pimephales promelas	Fathead minnow	FT	Meas	99.0%	60 d	25	F1 Survival	eggs	0.14	0.29	0.20	Rhodes et al. 1990
geomean											**0.20**	

Table 7. Acceptable reduced chronic data rated RR with reason for exclusion given below. S: static; SR: static renewal; FT: flow-through. NR: not reported

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference	Reason
Daphnia magna	Daphnid	FT	Meas	94.7%	21 d	20	Mortality	<24 h	0.04100	0.08000	0.05727	Forbis et al. 1984	A
Oncorhynchus mykiss	Rainbow trout	FT	Meas	96.0%	58 d	9.4	Total swimups	eggs	0.0848	0.16	0.11648 1758	Carlisle 1985	A
Oncorhynchus mykiss	Rainbow trout	FT	Meas	96.0%	58 d	9.4	Larval mortality	eggs	0.0177	0.0318	0.02372 4671	Carlisle 1985	A

Reasons for Exclusion

A. Less sensitive endpoint

Table 8. Acute-to-Chronic Ratios used for derivation of the cyfluthrin chronic criterion.

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	MATC	LC_{50}	ACR (LC_{50}/MATC)	Chronic Reference	Acute Reference
Daphnia magna	Daphnid	FT	Meas	94.7/ 98.6%	0.02864	0.160	5.58659	Forbis et al. 1984	Burgess 1990
Oncorhynchus mykiss	Rainbow trout	FT	Meas	96.0%	0.0133	0.2512	18.88970	Carlisle 1985	Bowers 1994, Gagliano & Bowers 1994
Pimephales promelas	Fathead minnow	FT	Meas	99.0%	0.20149	2.49	12.35793	Rhodes et al. 1990	Rhodes et al. 1990
Multi-species ACR = geomean (individual ACRs)							**10.27**		

Table 9. Excluded chronic toxicity data from studies rated RL, LR, or LL. S: static; SR: static renewal; FT: flow-through. NR: not reported, NC: not calculable.

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/ size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference
Cyprinodon variegatus	Sheepshead minnow	FT	Meas	90.5%	39 d	26	Survival	eggs	0.0247	0.0841	0.0456	Johnson et al. 1986
Cyprinodon variegatus	Sheepshead minnow	FT	Meas	90.5%	39 d	26	Dry weight	eggs	0.134	0.295	0.199	Johnson et al. 1986
Cyprinodon variegatus	Sheepshead minnow	FT	Meas	93.0%	28 d	25	Survival	eggs	0.27	0.63	0.41	Carr 1986a
Mysidopsis bahia	Opossum shrimp	FT	Meas	97.0%	28 d	25	Survival	< 24 h	0.00017	0.00042	0.00027	Hoberg et al. 1986
Mysidopsis bahia	Opossum shrimp	FT	Meas	97.0%	28 d	25	Reproduction (young/female/ repro. d)	< 24 h	0.00067	0.00125	0.00092	Hoberg et al. 1986
Mysidopsis bahia	Opossum shrimp	FT	Meas	97.0%	28 d	25	Dry weight (female)	< 24 h	0.00017	0.00042	0.00027	Hoberg et al. 1986
Mysidopsis bahia	Opossum shrimp	FT	Meas	97.0%	28 d	25	Dry weight (male)	< 24 h	0.00017	0.00042	0.00027	Hoberg et al. 1986

Reasons for Exclusion

1. Not a standard method
2. Saltwater
3. Control response unacceptable or not reported

Table 10. Acceptable multispecies field, semi-field, laboratory, microcosm, mesocosm studies; R= reliable; L= less reliable.

Reference	Habitat	Rating
Gunther & Herrmann 1986	Artificial ponds	R
Morris 1991	Microcosms	R
Johnson 1992	Outdoor experimental tanks	R
Johnson *et al.* 1994	Outdoor experimental tans	R
Kennedy *et al.* 1990	Artificial ponds	R
Morris et al. 1994	Microcosms and mesocosms	L

Appendix A

Fit test calculations

Cyfluthrin all LC 50s	Omit one 1	2	3	4	5	6	7	8
0.0023		0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
0.062	0.062		0.062	0.062	0.062	0.062	0.062	0.062
0.155	0.155	0.155		0.155	0.155	0.155	0.155	0.155
0.16	0.16	0.16	0.16		0.16	0.16	0.16	0.16
0.2512	0.2512	0.2512	0.2512	0.2512		0.2512	0.2512	0.2512
0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5
0.998	0.998	0.998	0.998	0.998	0.998	0.998		0.998
2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	

Omitted point, xi:	0.0023	0.0620	0.1550	0.1600	0.2512	0.5000	0.9980	2.4900
median 5th percentile Burr III	0.035975	0.0039497	0.003187	0.00317	0.00299	0.002911	0.003052	0.003711
percentile	0.14	28.84	46.9	47.55	56.88	70.35	81.81	92.56
F-i(xi)	0.0014	0.2884	0.469	0.4755	0.5688	0.7035	0.8181	0.9256
1-F(xi)	0.9986	0.7116	0.531	0.5245	0.4312	0.2965	0.1819	0.0744
Min of F-i(xi) or 1-F(xi)	0.0014	0.2884	0.469	0.4755	0.4312	0.2965	0.1819	0.0744
p_i =2(min)	0.0028	0.5768	0.938	0.951	0.8624	0.593	0.3638	0.1488

p_i	$\ln(p_i)$	Fisher test statistic -2*Sum of ln (pi)	X^2_{2n}	
0.0028	-5.8781	20.2591	0.2088	0.2088 is > 0.05 so the distribution fits the cyfluthrin acute data set
0.5768	-0.5503			
0.9380	-0.0640			if $X^2 < 0.05$ significant lack of fit
0.9510	-0.0502			if $X^2 > 0.05$ fit (no significant lack of fit)
0.8624	-0.1480			
0.5930	-0.5226			
0.3638	-1.0112			
0.1488	-1.9052			

Appendix B

Data summary sheets

Abbreviations used in this appendix:
NR = Not Reported
n/a = not applicable

Study Ratings:
RR = Relevant, Reliable
RL = Relevant, Less Reliable
LR =Less Relevant, Reliable
LL = Less Relevant, Less Reliable
RN = Relevant, Not Reliable
LN = Less Relevant, Not Reliable
N = Not Relevant

Unused lines deleted from tables

Summary sheets are in alphabetical order according to species, when there is more than one summary per species, they are in alphabetical order according to author.

Toxicity Data Summary

Aedes aegypti

Study: Rodriguez MM, Bisset J, Ruiz M, Soca A. 2002. Cross-resistance to pyrethroid and organophosphorus insecticides induced by selection with temephos in *Aedes aegypti* (Diptera: Culicidae) from Cuba. J. Med. Entomol. 39(6): 882-888.

Relevance
Score: 82.5 (Standard method, No control response)
Rating: L

Reliability
Score: 52.5
Rating: N

Reference	**Rodriguez *et al.* 2002**	***A. aegypti***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Culicidae	
Genus	*Aedes*	
Species	*Aegypti*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Larvae < 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	24 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	NR	
Temperature	NR	
Test type	Static	
Photoperiod/light intensity	NR	
Dilution water	Tap water	
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	No	
Purity of test substance	93%	

Reference	**Rodriguez *et al.* 2002**	***A. aegypti***
Parameter	**Value**	**Comment**
Concentrations measured?	No	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	1 mL acetone /100 mL water	
Concentration 1 Nom/Meas (µg/L)	5 concentrations	20/rep x 2
Control	Water and methanol control	20/rep x 2
LC_{50} (95% Confidence interval) for 4 strains* in µg/L	Rockefellar (susceptible): 1.3 (1.1-1.5) Santiago de Cuba: 7.8 (6.9-9) SAN-F3: 42 (32-49) SAN-F6: 45 (35-62)	Probit (Finney 1971)

***Rockefellar**: laboratory susceptible strain of Caribbean origin, colonized in the early 1930s, provided by the CDC laboratory in San Juan, Puerto Rico.
Santiago de Cuba: natural population collected from Santiago de Cuba, Cuba in 1998 and bred for 6 generations with for temfos resistance
SAN-F3: 3rd generation of Santiago de Cuba bred for temephos resistance
SAN-F6: 6th generation of Santiago de Cuba bred for temephos resistance

Reliability points taken off for:
Documentation: Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3), Hypothesis tests (8)

Acceptability: Standard method (5), Control response (9), Meas. Concentrations 20% Nom (4), Concentrations not ≥ 2x water solubility (4), Carrier solvent ≤ 0.5 mL/L (4), Organisms randomized (1), Dilution water (2), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature (6), Conductivity (1), pH (2), Photoperiod (2), Test vessels randomized (2), Appropriate spacing between concentrations (2), Hypothesis tests (3)

Toxicity Data Summary

Aedes aegypti

Study: Rodriguez MM, Bisset JA, Fernandez D. 2007. Levels of insecticide resistance and resistance mechanisms in *Aedes aegypti* from some Latin American countries. Journal of the American Mosquito Control Association. 23(4): 420-429.

Relevance
Score: 100
Rating: R

Reliability
Score: 76.5
Rating: R

Reference	**Rodriguez *et al.* 2007**	***A. aegypti***
Parameter	**Value**	**Comment**
Test method cited	WHO 1981	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Culicidae	
Genus	*Aedes*	
Species	*aegypti*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Early 4th instar larvae	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes †	
Test vessels randomized?	Yes †	
Test duration	24 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	100% †	
Temperature	25 °C †	
Test type	Static	
Photoperiod/light intensity	12 L:12 D †	
Dilution water	Tap water	
pH	NR	
Hardness	9 °d † (160 mg/L as CaCO3)	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	7 mg/mL †	
Feeding	No	
Purity of test substance	93%	

Reference	**Rodriguez *et al.* 2007**	***A. aegypti***
Parameter	**Value**	**Comment**
Concentrations measured?	No	
Measured is what % of nominal?	n/a	
Chemical method documented?	n/a	
Concentration of carrier (if any) in test solutions	1 mL acetone /100 mL water	
Concentration 1 Nom (µg/L)	10 † (conc. >2x sol)	20/rep x 2
Concentration 2 Nom (µg/L)	1 †	20/rep x 2
Concentration 3 Nom (µg/L)	0.1 †	20/rep x 2
Concentration 4 Nom (µg/L)	0.01 †	20/rep x 2
Concentration 5 Nom (µg/L)	0.001 †	20/rep x 2
Concentration 6 Nom (µg/L)	0.0001 †	20/rep x 2
Control	Water and methanol control	20/rep x 2
LC_{50} (95% Confidence interval) for 8 strains in µg/L	**Rockefellar (susceptible): 1 (1-2)** Santiago de Cuba: 8 (7-9)* Havana City: 10 (9-10)* Jamaica: 5 (4-5)* Panama: 10 (9-10)* Costa Rica: 5 (5-6)* **Nicaragua: 0.5 (0.5-0.6)** **Peru: 0.3 (0.1-0.4)** Venezuela: 5.9 (5-6)*	Probit (Finney 1971)

* Indicates that toxicity values are more than 2x the accepted water solubility (2.3 µg/L) and will not be used for criteria calculation.

Rockefellar: laboratory susceptible strain of Caribbean origin, colonized in the early 1930s, provided by the CDC laboratory in San Juan, Puerto Rico.
Santiago de Cuba: natural population collected from Santiago de Cuba, Cuba in 2002 during last dengue epidemic
Havana City: natural population collected from Havana City, Cuba in 2002 during last dengue epidemic
Jamaica: collected in 1998 and maintained in laboratory without exposure to insecticides
Costa Rica: collected in 1998 and maintained in laboratory without exposure to insecticides
Panama: collected in 1998 and maintained in laboratory without exposure to insecticides
Nicaragua: collected in 1998 and maintained in laboratory without exposure to insecticides
Peru: collected in 1998 and maintained in laboratory without exposure to insecticides
Venezuela: collected in 1998 and maintained in laboratory without exposure to insecticides

†Indicates information not contained in original article and obtained from the author Dr. Maria M. Rodriguez via email (mrodriguez@ipk.sld.cu).

Reliability points taken off for:
Documentation: Analytical method (4), Measured concentrations (3), Alkalinity (2), Conductivity (2), pH (3), Hypothesis tests (8)
Acceptability: Meas. Concentrations 20% Nom (4), Concentrations >2x water solubility (4), Carrier solvent > 0.5 mL/L (4), Alkalinity (2), Temperature range (3), Conductivity (1), pH (2), Appropriate spacing between concentrations (2), Hypothesis tests (3)

Toxicity Data Summary

Aedes albopictus and A. aegypti

Study: Sulaiman S, Pawanchee ZA, Othman HF, Shaari N, Yahaya S, Wahab A, Ismail S. 1995. Field evaluation of cypermethrin and cyfluthrin against dengue vectors in a housing estate in Malaysia. Journal of Vector Ecology December: 230-234.

Relevance
Rating: N →

Used 1.5% (w/v) formulation mixed with diesel.

Toxicity Data Summary

Ceriodaphnia dubia
Daphnia magna

Study: Mokry, LE & Hoagland KD. 1990. Acute toxicities of five synthetic pyrethroid insecticides to *Daphnia magna* and *Ceriodaphnia dubia*. Environmental Toxicology & Chemistry 9 (8): 1045-1051.

Relevance
Score: 67.5 (purity-25.4 %, no std method, control response NR)
Rating: N

Toxicity Data Summary

Ceriodaphnia dubia

Study: Wheelock CE, Miller JL, Miller MJ, Gee SJ, Shan G, Hammock BD. 2004. Development of toxicity identification evaluation procedures for pyrethroid detection using esterase activity. Environmental Toxicology and Chemistry 23(11): 2699-2708

Relevance
Score: 100
Rating: R

Reliability
Score: 74
Rating: R

Reference	**Wheelock *et al.* 2004**	***C. dubia***
Parameter	**Value**	**Comment**
Test method cited	EPA	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture, AQUA-Science, Davis, CA	
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	> 90%	
Temperature	25 +/- 1 °C	
Test type	Static	
Photoperiod/light intensity	16:8 light: dark	
Dilution water	EPA moderately hard	
pH	7.4-7.8	
Hardness	80-100 mg/L	
Alkalinity	60-70 mg/L	
Conductivity	Measured but NR	
Dissolved Oxygen	Measured but NR	
Feeding	None during test	

Reference	**Wheelock *et al.* 2004**	***C. dubia***
Parameter	**Value**	**Comment**
Purity of test substance	>97%	
Concentrations measured?	No	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	<1%	
Concentration 1 Nom/Meas (μg/L)	5-7 concentrations	2-4 w/ 5 neonates each, distributed in 'stratified random assortment'
Control	Water and methanol control	Reps and # per (cell density for single
LC_{50}	48 h: 0.344 +/- 0.041 μg/L	ToxCal software, but no stat method reported

Reliability points taken off for:
Documentation: Nominal concentrations (3), Measured concentrations (3), Dissolved Oxygen (4), Conductivity (2), Statistical methods identified (5), Hypothesis tests (8)

Acceptability: Meas. Concentrations 20% Nom (4), Carrier solvent ≤ 0.5 mL/L (4), Exposure type (2), Appropriate spacing between concentrations (2), Appropriate statistical method (2), Hypothesis tests (3)

Toxicity Data Summary

Ceriodaphnia dubia

Study: Yang WC, Hunter W, Spurlock F, Gan J. 2007. Bioavailability of permethrin and cyfluthrin in surface waters with low levels of dissolved organic matter. *J. Environ. Qual.* 36:1678-1685.

Relevance
Score: 100
Rating: R

Reliability
Score: 78.5
Rating: R

Reference	**Yang *et al.* 2007**	***C. dubia***
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993	Effluent toxicity tests
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Neonates, < 24 h	
Source of organisms	Lab cultures	Aquatic BioSystems, Fort Collins, CO
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes, several months	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	< 10% for all waters tested	
Temperature	21 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16 L: 8 D	
Dilution water	15 filtered surface waters from Orange and Riverside Counties, CA	See notes below for key to numbered waters
pH	1) 7.30 2) 6.87 3) 6.85	

Reference	**Yang *et al.* 2007**	***C. dubia***
Parameter	**Value**	**Comment**
	4) 7.36 5) 7.76 6) 7.02 7) 7.14 8) 7.70 9) 7.24 10) 6.95 11) 7.05 12) 7.73 13) 7.29 14) 6.67 15) 6.85	
Hardness (mg/L)	1) 303 2) >1000 3) 200 4) 162 5) 223 6) >1000 7) >1000 8) 270 9) 365 10) 308 11) >1000 12) 440 13) 200 14) 302 15) 220	
Alkalinity (mg/L)	1) 323 2) 318 3) 180 4) 118 5) 204 6) 361 7) 317 8) 230 9) 269 10) 235 11) 470 12) 130 13) 223 14) 304 15) 198	
Conductivity	NR	
Dissolved Oxygen	NR	

Reference	**Yang *et al.* 2007**	***C. dubia***
Parameter	**Value**	**Comment**
Feeding	Yes, shortly before exposure and at 48 h	
Purity of test substance	99%	
Concentrations measured?	No	
Measured is what % of nominal?	n/a	
Chemical method documented?	n/a	
Concentration of carrier (if any) in test solutions	$\leq$ 0.1% acetone	
Concentration 1 Nom/Meas (µg/L)	0.02	5 org/rep
Concentration 2 Nom/Meas (µg/L)	0.05	
Concentration 3 Nom/Meas (µg/L)	0.1	
Concentration 4 Nom/Meas (µg/L)	0.2	water
Concentration 5 Nom/Meas (µg/L)	0.6	
Control	Dilution waters, DI water	
LC_{50} (95% confidence interval) (µg/L)	0) 0.093 (0.050-0.146) 1) 0.210 (0.154-0.288)* 2) 0.136 (0.103-0.185) 3) 0.187 (0.138-0.271)* 4) 0.189 (0.112-0.292) 5) 0.134 (0.097-0.194) 6) 0.192 (0.126-0.279)* 7) 0.170 (0.121-0.229) 8) 0.145 (0.105-0.185) 9) 0.102 (0.027-0.395) 10) 0.209 (0.144-0.298)* 11) 0.177 (0.131-0.253)* 12) 0.193 (0.142-0.283)* 13) 0.159 (0.105-0.234) 14) 0.184 (0.121-0.275)* 15) 0.180 (0.127-0.280)	Method: Probit * indicates significantly different than DI water control (0), these values were excluded from the RR data set because they had high DOM concentrations.

Notes:
-LC_{50} calculated based on nominal concentrations.
-*D. magna* bioaccumulation: in 14 of the 15 water samples the mean cyfluthrin body residue was lower than in the control water, 9 of those were statistically significant (p = 0.05)
-Water identifications (see article for additional water quality characteristics):
0) Control water (deionized water)
1) San Joaquin Marsh Reserve inlet, Orange County, CA
2) San Diego Creek near Campus Dr. Orange County, CA
3) Lake Evans in Fairmount Park, Riverside, CA
4) Brown Lake in Fairmount Park, Riverside, CA
5) Fairmount Lake in Fairmount Park, Riverside, CA
6) Peters Canyon Creek near Irvine, Orange County, CA
7) San Diego Creek near Irvine, Orange County, CA

8) Santa Ana River, Riverside, CA
9) Sycamore Canal, Riverside, CA
10) Botanic Garden pond near UC Riverside Campus, Riverside, CA
11) Santa Clara River near Saticoy City, CA
12) A pond near Saticoy City, CA
13) Lake Elsinore, Riverside County, CA
14) Rancho Jurupa Park pond, Riverside, CA
15) Trabuco Canyon Creek, Riverside, CA

Reliability points taken off for:
Documentation: Analytical method (4), Measured concentrations (4), Dissolved oxygen (4), Conductivity (2), Hypothesis tests (8)
Acceptability: Measured concentrations w/in 20% nominal (4), Carrier solvent (4), Organisms randomized (1), Dissolved oxygen (6), Conductivity (1), Random design (2), Adequate replication (2), Hypothesis tests (3).

Toxicity Data Summary

Crassostrea virginica

Study: Barrows B. 1984b. Shell deposition in Eastern oyster (*Crassostrea virginica*) exposed to cyfluthrin technical in a static test system. Study number 88989. Biospherics Incorporated, Rockville, MD. CDPR ID: 50317-090.

Relevance
Score: 85 (Saltwater)
Rating: L

Reliability
Score: 84
Rating: R

Reference	**Barrows 1984b**	***C. virginica***
Parameter	**Value**	**Comment**
Test method cited	EPA and Fifra, 40 CFR part 160	
Phylum/subphylum	Mollusca	
Class	Bivalvia	
Order	Ostreoida	
Family	Ostreidae	
Genus	*Crassostrea*	
Species	*virginica*	
Family in North America?	Yes	
Age/size at start of test/growth phase	41.2 mm (33.8mm-49.7 mm)	
Source of organisms	Chesapeake Bay Oyster Culture, Shady Side MD	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	No	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Shell deposition	Solvent Control
Control response 1	0.15 mm	
Effect 2	Amt of new shell growth	Water Control
Control response 2	Shell thinning	Anomaly- discarded
Temperature	21°C	
Test type	Static	
Photoperiod/light intensity	16 L:8 D	
Dilution water	Deionized water +Instant ocean	
pH	7.7-8.0	
Hardness	2000 mg/L as CaCO3	

Reference	**Barrows 1984b**		***C. virginica***
Parameter	**Value**		**Comment**
Alkalinity	134 mg/L as CaCO3		
Conductivity	None		
Dissolved Oxygen	5.3-8 ppm		
Feeding	Yes, during study		
Purity of test substance	87%		
Concentrations measured?	No		
Measured is what % of nominal?	No		
Chemical method documented?	No		
Concentration of carrier (if any) in test solutions	0.5 mL/L		Acetone
Concentration 1 Nom/Meas (mg/L)	Nominal 0.0013	Measured n/a	 1 rep with 20 oysters
Concentration 2 Nom/Meas (mg/L)	0.0022	n/a	1 rep with 20 oysters
Concentration 3 Nom/Meas (mg/L)	0.0036	n/a	1 rep with 20 oysters
Concentration 4 Nom/Meas (mg/L)	0.006	n/a	1 rep with 20 oysters
Concentration 5 Nom/Meas (mg/L)	0.01	n/a	1 rep with 20 oysters
Control	Water and solvent		1 rep with 20 oysters
EC_{50}	0.005 mg AI/L		Method: Linear Regression

Notes:

NOEC/LOEC calculated based on nominal concentrations

Reliability points taken off for:
Documentation (3.7):
Analytical method was not measured for the chemical (4), No measured concentrations were reported (3), No conductivity reported (2), Hypothesis tests do not apply (8).

Acceptability (3.8):
Measured concentrations were not measured (4), Adequate number per replicate/appropriate cell density was not achieved (2), Organisms were fed during the study (3), No conductivity reported (1), Only 2 replicates conducted, which is not adequate (2), The hypothesis test does not apply (3).

Toxicity Data Summary

Crassostrea virginica

Study: Carr RS. 1986b. The oyster shell deposition test to assess the acute effects of Baythroid on the Eastern oyster (*Crassostrea virginica*). Mobay Chemical Corp. Battelle New England Marine Research Laboratory, Duxbury, MA. Study number 91889. CDPR ID: 50317-053 and 50317-090.

Relevance
Score: 85 (Saltwater)
Rating: L

Reliability
Score: 82.5
Rating: R

Reference	**Carr 1986b**	***C. virginica***
Parameter	**Value**	**Comment**
Test method cited	EPA and Fifra, 40 CFR part 160	
Phylum	Mollusca	
Class	Bivalvia	
Order	Ostreoida	
Family	Ostreidae	
Genus	*Crassostrea*	
Species	*virginica*	
Family in North America?	Yes	
Age/size at start of test/growth phase	2.0-4.0 cm prespawn condition	
Source of organisms	Aquaculture Research Corp	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Shell growth	
Control response 1	Dil water: 1.7 mm, Solvent: 2.1 mm	
Temperature	21°C	
Test type	Flow Through	
Photoperiod/light intensity	14 L:10 D	
Dilution water	Seawater Filtered	
pH	7.85-7.98	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	

Reference	**Carr 1986b**		***C. virginica***
Parameter	**Value**		**Comment**
Dissolved Oxygen	> 69% saturation		
Feeding	Yes, Isochrysis galbana		During study
Purity of test substance	95.2%		
Concentrations measured?	Yes		
Measured is what % of nominal?	76-94%		
Chemical method documented?	Yes, GC		
Concentration of carrier (if any) in test solutions	0.15 mL/L acetone		
Concentration 1 Nom/Meas (µg/L)	Nominal 20	Measured (mean) 12.8	 2 reps with 10 oysters
Concentration 2 Nom/Meas (µg/L)	10	6.1	2 reps with 10 oysters
Concentration 3 Nom/Meas (µg/L)	5	4.7	2 reps with 10 oysters
Concentration 4 Nom/Meas (µg/L)	2.5	1.9	2 reps with 10 oysters
Concentration 5 Nom/Meas (µg/L)	1.25	0.9	2 reps with 10 oysters
Control	Dilution water and solvent		2 reps with 10 oysters
EC_{50} (µg/L)	96 h: 3.42 (2.99-3.95)		Method: Moving Average
NOEC (µg/L)	4.7		Method: Williams test p: NR MSD: NR
LOEC (µg/L)	6.1		
MATC (GeoMean NOEC,LOEC)	5.4 µg/L		
% control at NOEC	58%		
% of control LOEC	21%		

Notes:
-This study can be found under with the study 50317-090 Mallard Repro 1986 study
-NOEC/LOEC calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
No hardness reported (2), No Alkalinity reported (2), No conductivity reported (2), Hypothesis tests do not apply (8).

Acceptability (3.8):
Measured concentrations (all but one) were below 80% of nominal (4), Concentrations (total 3 out of 5) were above 2x solubility (4), Organisms were fed during the study (3), No

hardness reported (2), No Alkalinity reported (2), No conductivity reported (1), Only 2 replicates conducted, which is not adequate (2), The hypothesis test does not apply (3).

Toxicity Data Summary

Culex quinquefasciatus

Study: Halliday WR Georghiou GP. 1985. Cross-resistance and dominance relationships of pyrethroids in a permethrin-selected strain of *Culex quinquefasciatus* (Diptera: Culicidae). Journal of Economic Entomology 78: 127-1232.

Relevance
Score: 82.5 (No std method, Control not described)
Rating: L

Reliability
Score: 47
Rating: N

Reference	**Halliday & Georghiou 1985**	***C. quinquefasciatus***
Parameter	**Value**	**Comment**
Test method cited	Ref Georghiou 1966	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Culicidae	
Genus	*Culex*	
Species	*quinquefasciatus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	4^{th} instar	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	24 h	
Data for multiple times?	No	
Effect 1	Mortality	Susceptible and resistant strains tested
Control response 1	< or = 15%	
Temperature	NR	
Test type	static	
Photoperiod/light intensity	NR	
Dilution water	tap	
pH	NR	
Hardness	NR	
Alkalinity	NR	

Reference	**Halliday & Georghiou 1985**	***C. quinquefasciatus***
Parameter	**Value**	**Comment**
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	NR	
Purity of test substance	'Technical' no%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	10 mL/L	
Concentration 1 Nom/Meas (µg/L)	4 levels, but concentrations not reported	4 reps and 20 organisms per rep
Control	yes	
LC50; indicate calculation method	0.30 ug/L - susceptible 76 ug/L - resistant	probit

Reliability points taken off for:
Documentation: Control Type (8), Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3) Hypothesis tests (8).

Acceptability: Standard method (5), Control appropriate type (6), Meas. Concentrations 20% Nom (4), Concentrations do not exceed 2x water solubility (4), Carrier solvent ≤ 0.5 mL/L (4), Appropriate age/ size (3), Organisms randomly assigned to containers (1), Dilution water (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Temperature (6), Conductivity (1), pH (2), Photoperiod (2), Adequate number of concentrations (3), Appropriate spacing between concentrations (2), Random / block design (2), Hypothesis tests (3).

Toxicity Data Summary

Cyanobacteria:
Anabaena flos-aquae
Microcystis flos-aquae
Microcystis aeruginosa
Green algae:
Pseudokirchneriella subspicatus (Selenastrum capricornutum)
Scenedesmus quadricauda
Scenedesmus obliquus
Chlorella vulgaris
Chlorella pyrenoidosa

Study: Ma J. 2005. Differential sensitivity of three cyanobacterial and five green algal species to organotins and pyrethroids pesticides. Science of the Total Environment, 341:109-117.

N → all toxicity values reported are > 2x water solubility

Toxicity Data Summary

Cyprinodon variegatus

Study: Barrows B. 1984a. The static acute toxicity of cyfluthrin technical to the Sheepshead minnow *Cyprinodon variegatus*. Study number 88914. Biospherics Incorporated, Rockville, MD. CDPR ID: 50317-090.

Relevance
Score: 85 (Saltwater)
Rating: L

Reliability
Score: 85.5
Rating: R

Reference	**Barrows 1984a**	***C. variegatus***
Parameter	**Value**	**Comment**
Test method cited	FIFRA 40 CFR 160	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyprinodontiformes	
Family	Cyprinodontidae	
Genus	*Cyprinodon*	
Species	*variegatus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	0.55 g Average weight 23.5 mm Average length	
Source of organisms	Commercial Supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not specified	
Test duration	96 hr	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	0%	
Temperature	20 ± 1 degrees C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Reconstituted Salt water with DI water	
pH	7.9-8.1	
Hardness	7500 mg/L	
Alkalinity	189 mg/L	
Conductivity	Not measured	
Dissolved Oxygen	4.0-7.2 ppm	
Feeding	None during study	

Reference	**Barrows 1984a**		***C. variegatus***
Parameter	**Value**		**Comment**
Purity of test substance	87%		
Concentrations measured?	No		
Measured is what % of nominal?	Not measured		
Chemical method documented?	No		
Concentration of carrier (if any) in test solutions	0.5 mL/L		DMF
Concentration 1 Nom/Meas (µg/L)	Nominal 1.3	Measured Not measured	1 rep 10 fish
Concentration 2 Nom/Meas (µg/L)	2.16	Not measured	1 rep 10 fish
Concentration 3 Nom/Meas (µg/L)	3.6	Not measured	1 rep 10 fish
Concentration 4 Nom/Meas (µg/L)	6	Not measured	1 rep 10 fish
Concentration 5 Nom/Meas (µg/L)	10	Not measured	1 rep 10 fish
Control	Solvent and water		1 rep 10 fish
LC_{50} (95% confidence interval) (µg/L)	24 h: 4.40 (3.6-6.0) 48 h: 4.40 (3.6-6.0) 72 h: 4.05 (2.16-6) 96 h: 4.05 (2.16-6)		Binomial probability method (Stephan 1979)

Notes:
-This study can be found under with the study 50317-090 Mallard Repro 1986 study.
-Calculations based on nominal concentrations

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
Concentrations were not measured: measured concentrations not within 20% of nominal (4), Conductivity not reported (1), It is unknown whether random block was utilized (2), Adequate replication was not done (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Cyprinodon variegatus

Study: Carr RS. 1986a. Chronic toxicity of Baythroid to the sheepshead minnow Cyprinodon variegatus. Mobay Chemical Co. Battelle Study. CDPR ID: 50317-090.

Relevance
Score: 85 (saltwater)
Rating: L

Reliability
Score: 84
Rating: R

Reference	**Carr 1986a**	***C. variegatus***
Parameter	**Value**	**Comment**
Test method cited	ASTM & US EPA	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyprinodontiformes	
Family	Cyprinodontidae	
Genus	*Cyprinodon*	
Species	*variegatus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Eggs	
Source of organisms	In-house lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	28 d	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	Dil water: 96%, Solv: 93%	
Effect 2	Hatching success	
Control response 2	Dil water: 99%, Solv: 93%	
Effect 3	Length	
Control response 3	Dil: 14 mm, Solv: 12.9 mm	
Effect 4	Wet weight	
Control response 4	Dil: 77.8 mg, Solv: 63 mg	
Temperature	24.8 ± 2.7°C	
Test type	FT	
Photoperiod/light intensity	14 L: 10 D	
Dilution water	Duxbury Bay seawater	
pH	7.45-8.22	
Hardness	NR	

Reference	**Carr 1986a**	***C. variegatus***
Parameter	**Value**	**Comment**
Alkalinity	NR	
Salinity	31.5-33.5 o/oo	
Dissolved Oxygen	≥ 76% sat	
Feeding	Yes, 2x/day	
Purity of test substance	93%	
Concentrations measured?	Yes	
Measured is what % of nominal?	54-63%	
Chemical method documented?	Yes, GC-ECD	
Concentration of carrier (if any) in test solutions	<0.014 % acetone	
Concentration 1 Nom/Meas (µg/L)	0.12/0.07	2 reps, 44-45 org/rep
Concentration 2 Nom/Meas (µg/L)	0.25/0.15	2 reps, 44-45 org/rep
Concentration 3 Nom/Meas (µg/L)	0.5/0.27	2 reps, 44-45 org/rep
Concentration 4 Nom/Meas (µg/L)	1/0.63	2 reps, 44-45 org/rep
Concentration 5 Nom/Meas (µg/L)	2/1.22	2 reps, 44-45 org/rep
Control	Dilution water and solvent	2 reps, 44-45 org/rep
NOEC (µg/L)	Survival: 0.27	Method: Williams test p: 0.05 MSD: NR
LOEC (µg/L)	Survival: 0.63	Same as above
MATC (GeoMean NOEC,LOEC)	0.41 µg/L	
% control at NOEC	Dil: 96.9% Solv: 100%	
% of control LOEC	Dil: 34.4% Solv: 35.5%	

Notes:

NOEC/LOEC calculated based on mean measured concentrations.

Reliability points taken off for:
Documentation: Hardness (2), Alkalinity (2), Conductivity (2), Minimum significant difference (2), Point estimates (8).
Acceptability: Measured concentration w/in 20% of nominal (4), Hardness (2), Alkalinity (2), Temperature range (3), Conductivity (1), MSD (1), Point estimates (8).

Toxicity Data Summary

Cyprinodon variegatus

Study: Johnson I, Ward GS, Rhoads P, Coulombe W, Dose E. 1986. Effects of cyfluthrin on survival, growth, and development of sheepshead minnow (Cyprinodon variegatus). Mobay Chemical Co. CDPR ID: 50317-090.

Relevance		Reliability
Score: 75	(No std method, saltwater)	Score: 77.5
Rating: L		Rating: R

Reference	**Johnson *et al.* 1986**	***C. variegatus***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyprinodontiformes	
Family	Cyprinodontidae	
Genus	*Cyprinodon*	
Species	*variegatus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Eggs	
Source of organisms	Parent generation collected from the coast off Florida	
Have organisms been exposed to contaminants?	Possibly	
Animals acclimated and disease-free?	Parent generation acclimated 1 d, Disease possible	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	39 d	
Data for multiple times?	No	
Effect 1	Time to hatch	
Control response 1	Dil water: 8 d, Solv: 11d	
Effect 2	Survival	
Control response 2	Dil water: 80%, Solv: 91%	
Effect 3	Dry Weight	
Control response 3	Dil water: 6.4 mg, Solv: 9.3 mg	
Temperature	26 ± 2°C	
Test type	FT	
Photoperiod/light intensity	14 L: 10 D	
Dilution water	Natural seawater (filtered and sterilized) diluted with	

Reference	**Johnson *et al.* 1986**	***C. variegatus***
Parameter	**Value**	**Comment**
	well water	
pH	7.5-8.7	
Hardness	NR	
Alkalinity	NR	
Salinity	20 o/oo	
Dissolved Oxygen	≥ 45% sat	
Feeding	1x/day	
Purity of test substance	90.5%	
Concentrations measured?	Yes	
Measured is what % of nominal?	67.2-110.2%	
Chemical method documented?	GC-ECD	
Concentration of carrier (if any) in test solutions	0.0114 mL/L	
Concentration 1 Nom/Meas (ng/L)	50/12.2	2 reps, 20 org/rep
Concentration 2 Nom/Meas (ng/L)	100/24.7	2 reps, 20 org/rep
Concentration 3 Nom/Meas (ng/L)	200/82.2	2 reps, 20 org/rep
Concentration 4 Nom/Meas (ng/L)	400/134	2 reps, 20 org/rep
Concentration 5 Nom/Meas (ng/L)	800/295	2 reps, 20 org/rep
Concentration 6 Nom/Meas (ng/L)	1600/527	2 reps, 20 org/rep
Control	Dilution water and solvent	2 reps, 20 org/rep
NOEC (ng/L)	Survival: 24.7 * Dry Weight: 134	Method: ANOVA, William's or Dunnett's test p: 0.05 MSD: NR
LOEC (ng/L)	Survival: 84.1 * Dry Weight: 295	Same as above
MATC (GeoMean NOEC,LOEC)	Survival: 45.6 ng/L	
% control at NOEC	Dil: 105%, Solv: 92.3%	
% of control LOEC	Dil: 66.2%, Solv: 58.2%	

Notes:
*Indicates most sensitive endpoint(s).
-NOEC/LOEC calculated based on mean measured concentrations.
-Bacterial growth and low dissolved oxygen levels likely caused effects other than those due to cyfluthrin.

Reliability points taken off for:
Documentation: Hardness (2), Alkalinity (2), Conductivity (2), Minimum significant difference (2), Point estimates (8).
Acceptability: Measured conc w/in 20% nominal (4), Prior contamination (4), Proper acclimation (1), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature range (3), Conductivity (1), Random design (2), MSD (1), Point estimates (3).

Toxicity Data Summary

Cyprinus carpio

Study: Sepici-Dincel A, Benli ACK, Selvi M, Sarikaya R, Sahin D, Ozkul IA, Erkoc F. 2009. Sublethal cyfluthrin toxicity to carp (Cyprinus carpio L) fingerlings: Biochemical, hematological, histopathological alterations. Ecotoxicology and Environmental Safety 72: 1433-1439.

Relevance
Rating: N →

Not usable because all conc. > 2x water solubility

Toxicity Data Summary

Daphnia magna

Study: Brausch JM, Smith PN. 2009. Development of resistance to cyfluthrin and naphthalene among *Daphnia magna.* Ecotoxicology, 18:600-609.

Relevance
Score: 85 (Low chemical purity)
Rating: L

Reliability
Score: 84
Rating: R

Reference	**Brausch & Smith 2009**	***D. magna***
Parameter	**Value**	**Comment**
Test method cited	US EPA 2002	EPA-821-R-02-012
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h old	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No for F0, yes in selected resistant generations	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	> 90%	
Temperature	25 ± 0.2 °C	
Test type	Static	
Photoperiod/light intensity	14 L: 10 D	
Dilution water	Moderately hard water	Synthetic
pH	7.9-8.3	
Hardness	80-100 mg/L	
Alkalinity	57-64 mg/L	
Conductivity	NR	
Dissolved Oxygen	Measured but NR	
Feeding	None during test	
Purity of test substance	11.8%	
Concentrations measured?	No	

Reference	**Brausch & Smith 2009**	***D. magna***
Parameter	**Value**	**Comment**
Measured is what % of nominal?	n/a	
Chemical method documented?	n/a	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Nom (µg/L)	0.001	4 reps, 5 orgs/rep
Concentration 2 Nom (µg/L)	0.01	4 reps, 5 orgs/rep
Concentration 3 Nom (µg/L)	0.1	4 reps, 5 orgs/rep
Concentration 4 Nom (µg/L)	0.25	4 reps, 5 orgs/rep
Concentration 5 Nom (µg/L)	1.25	4 reps, 5 orgs/rep
Control	Dilution water	4 reps, 5 orgs/rep
LC_{50} (95% confidence interval) (µg/L)	F0: 0.62 F13: 2.91*	Method: Logit analysis
NOEC (µg/L)	0.01	Method: 1 way ANOVA, Dunnett's test p: 0.05 MSD: NR
LOEC (µg/L)	0.1	Same as above
MATC (geomean NOEC, LOEC)	0.03 µg/L	
% NOEC at control	NR	
% LOEC at control	NR	

Notes:
*The F13 generation LC_{50} value is not considered relevant for criteria derivation because the test was with organisms that were bred to be resistant to cyfluthrin.
-LC_{50} calculated based on nominal concentrations.
-This study also measured toxicity in many generations of *Daphnia* bred to be resistant to cyfluthrin and toxicity of mixtures of cyfluthrin and PBO.

Reliability points taken off for:
Documentation: Analytical method (4), Measured concentrations (3), Dissolved oxygen (4), Conductivity (2), Hypothesis tests (4)
Acceptability: Measured concentrations w/in 20% of nominal (4), Organisms randomized (1), Dissolved oxygen (6), Conductivity (1), Random design (2), MSD (1).

Toxicity Data Summary

Daphnia magna

Study: Burgess D. 1990. Acute Flow through toxicity of ^{14}C-cyfluthrin to *Daphnia magna*. CDPR ID: 50317-135.

Relevance
Score: 100
Rating: R

Reliability
Score: 90
Rating: R

Reference	**Burgess 1990**	***D. magna***
Parameter	**Value**	**Comment**
Test method cited	EPA and Fifra, 40 CFR part 160	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Family in North America?	Yes	
Age/size at start of test/growth phase	≤ 24 hours old	
Source of organisms	Laboratory Cultures	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not stated	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	0%	
Temperature	19 ±1ºC	
Test type	Flow Through	
Photoperiod/light intensity	16 L:8 D	
Dilution water	Reverse Osmosis water + well water blend	
pH	7.5-7.6	
Hardness	175-178 mg/L	
Alkalinity	207-208 mg./L	
Conductivity	340-355 uMhos/cm	
Dissolved Oxygen	7.5-8.1 mg/L	
Feeding	None	

Reference	**Burgess 1990**		***D. magna***
Parameter	**Value**		**Comment**
Purity of test substance	98.6%		
Concentrations measured?	Yes		
Measured is what % of nominal?	67-113%		
Chemical method documented?	Yes, LSC		
Concentration of carrier (if any) in test solutions	0.l mL/L		Acetone
Concentration 1 Nom/Meas (µg/L)	Nominal 0.018	Measured (mean) 0.016	4 reps w/10 animals
Concentration 2 Nom/Meas (µg/L)	0.036	0.028	4 reps w/10 animals
Concentration 3 Nom/Meas (µg/L)	0.075	0.056	4 reps w/10 animals
Concentration 4 Nom/Meas (µg/L)	0.15	0.10	4 reps w/10 animals
Concentration 5 Nom/Meas (µg/L)	0.3	0.24	4 reps w/10 animals
Control	Dilution water and solvent		4 reps w/10 animals
LC_{50} (µg/L)	48 h: 0.16 (0.14-0.18)		Method: Moving Average

Notes:
-LC_{50} calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
Hypothesis tests do not apply (8).

Acceptability (3.8):
Measured concentrations were below 80% of nominal (4), It is not known whether the organisms were fed during the study (3), Random or Random block design employment was not reported (2), The hypothesis test does not apply (3).

Toxicity Data Summary

Daphnia magna

Study: Carlisle JC, Carsel MA. 1983b. Acute Toxicity of Technical Cyfluthrin (Baythroid) to *Daphnia magna*. CDPR ID: 50317-003.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 77.5
Rating: R

Reference	**Carlisle & Carsel 1983b**	***D. magna***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Family in North America?	Yes	
Age/size at start of test/growth phase	First instar	
Source of organisms	Laboratory stock	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	No	
Test vessels randomized?	No	
Test duration	48 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	0%	
Temperature	19 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Dechlorinated tap	
pH	7.39-7.53	
Hardness	179 ppm	
Alkalinity	122 ppm	
Conductivity	NR	
Dissolved Oxygen	5.9-6.1	
Feeding	None during study	
Purity of test substance	87%	
Concentrations measured?	No	

Reference	**Carlisle & Carsel 1983b**		***D. magna***
Parameter	**Value**		**Comment**
Measured is what % of nominal?	n/a		
Chemical method documented?	n/a		
Concentration of carrier (if any) in test solutions	Not specified		
Concentration 1 Nom/Meas (µg/L)	Nominal 0.01	Measured Not measured	1 rep with 10 organisms each
Concentration 2 Nom/Meas (µg/L)	0.026	Not measured	1 rep with 10 organisms each
Concentration 3 Nom/Meas (µg/L)	0.068	Not measured	1 rep with 10 organisms each
Concentration 4 Nom/Meas (µg/L)	0.177	Not measured	1 rep with 10 organisms each
Concentration 5 Nom/Meas (µg/L)	0.460	Not measured	1 rep with 10 organisms each
Concentration 6 Nom/Meas (µg/L)	1.197	Not measured	1 rep with 10 organisms each
Control	Dilution water		1 rep with 10 organisms each
LC_{50} (µg/L)	48 hr: 0.141		Method: Probit method

Notes:
-This study can be found under with the study 50317-003 Mallard LC50
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
No acceptable standard method identified (5), No Solvent control included (6), It is unknown whether measured concentrations were not within 20% of nominal (4), It is unknown what concentrations carrier solvent was utilized (4), It is unknown whether the organisms were randomly assigned to test containers (1), Conductivity not reported (1), It is unknown whether random block was utilized (2), Each concentration was conducted once-this is not adequate replication (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Daphnia magna

Study: Forbis AD, Burgess D, Franklin L, Galbraith A. 1984. Chronic toxicity of ^{14}C-cyfluthrin to *Daphnia magna* under flow-through conditions. Analytical Bio-Chemistry Laboratories, Inc. Mobay Chemical Company. CDPR ID: 50317-090.

Relevance	Reliability
Score: 100	Score: 89
Rating: R	Rating: R

Reference	**Forbis *et al.* 1984**	***D. magna***
Parameter	**Value**	**Comment**
Test method cited	ASTM, US EPA	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	In-house continuous lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	21 d	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	Dil water: 15%, Solv: 5%	
Effect 2	Length	
Control response 2	4.2 $\pm$ 0.13 mm	
Effect 3	Young/adult/reproductive d	
Control response 3	11 $\pm$ 0.63	
Temperature	20 ± 1°C	
Test type	FT	
Photoperiod/light intensity	16 L:8D	
Dilution water	Well water	
pH	8.0-8.4	
Hardness	225-275 mg/L	

Reference	**Forbis *et al.* 1984**	***D. magna***
Parameter	**Value**	**Comment**
Alkalinity	325-375 mg/L	
Conductivity	700 μmhos/cm	
Dissolved Oxygen	6.5-8.7 mg/L (71-95% sat)	
Feeding	Yes, 3x per day	
Purity of test substance	94.7%	
Concentrations measured?	Yes	
Measured is what % of nominal?	63-100%	
Chemical method documented?	Yes, LSC and TLC	
Concentration of carrier (if any) in test solutions	NR	
Concentration 1 Nom/Meas (ng/L)	18/18	4 reps, 10 org/rep
Concentration 2 Nom/Meas (ng/L)	29/20	4 reps, 10 org/rep
Concentration 3 Nom/Meas (ng/L)	65/41	4 reps, 10 org/rep
Concentration 4 Nom/Meas (ng/L)	120/80	4 reps, 10 org/rep
Concentration 5 Nom/Meas (ng/L)	240/220	4 reps, 10 org/rep
Control	Dilution water and solvent	4 reps, 10 org/rep
NOEC (ng/L)	Mortality: 41 Length: 20 * Young/adult/repro d: 20 *	Method: 2-way and 1-way ANOVA p: 0.05 MSD: NR
LOEC (ng/L)	Mortality: 80 Length: 41 * Young/adult/repro d: 41 *	Same as above
MATC (GeoMean NOEC,LOEC)	Length & Young/adult/repro d: 28.6 ng/L	
% control at NOEC	Length: 100% Young/adult/repro d: 100%	
% of control LOEC	Length: 92.9% Young/adult/repro d: 60.9%	

Notes:
* Indicates most sensitive endpoints.
-NOEC/LOEC calculated based on mean measured concentrations.
-Degradation of the parent compound was observed with TLC analysis. For the highest concentration tested (240 ng/L nominal), only 37% of the activity detected was from the parent compound, meaning that the MATC may much lower than the concentration measured by LSC.

Reliability points taken off for:
Documentation: Minimum significant difference (2), Point estimates (8).
Acceptability: Measured concentration w/in 20% of nominal (4), Carrier solvent (4), Minimum significant difference (1), Point estimates (3).

Toxicity Data Summary

Daphnia magna

Study: Heimbach F. 1984a. Acute toxicity of FCR 1272 (Technical) to Water fleas.
CDPR ID: 50317-090.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 81
Rating: R

Reference	**Heimbach 1984a**	***D. magna***
Parameter	**Value**	**Comment**
Test method cited	None	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Family in North America?	yes	
Age/size at start of test/growth phase	First instar	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Not specified	
Test vessels randomized?	Not specified	
Test duration	48 hrs	
Data for multiple times?	24, 48 hrs	
Effect 1	Mortality	
Control response 1	0%	
Temperature	20 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Dechlorinated tap water	
pH	8.04	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	94.1%	
Feeding	None during study	
Purity of test substance	94.1%	
Concentrations measured?	No	

Reference	**Heimbach 1984a**		***D. magna***
Parameter	**Value**		**Comment**
Measured is what % of nominal?	n/a		
Chemical method documented?	n/a		
Concentration of carrier (if any) in test solutions	0.1 mL/L		Acetone
Concentration 1 Nom/Meas (µg/L)	Nominal 0.32	Measured Not measured	3 rep with 10 organisms each
Concentration 2 Nom/Meas (µg/L)	0.56	Not measured	3 rep with 10 organisms each
Concentration 3 Nom/Meas (µg/L)	1.0	Not measured	3 rep with 10 organisms each
Concentration 4 Nom/Meas (µg/L)	3.2	Not measured	3 rep with 10 organisms each
Concentration 5 Nom/Meas (µg/L)	5.6	Not measured	3 rep with 10 organisms each
Concentration 6 Nom/Meas (µg/L)	10	Not measured	3 rep with 10 organisms each
Concentration 7 Nom/Meas (µg/L)	32	Not measured	3 rep with 10 organisms each
Concentration 8 Nom/Meas (µg/L)	56	Not measured	3 rep with 10 organisms each
Control	Solvent and water		3 rep with 10 organisms each
EC_{50} (95% confidence interval) (µg/L)	24 h: > 56 48 h: 2.7 (1.4-4.7)		Method: Probit analysis

Notes:
-This study can be found under with the study 50317-090 mallard repro study.
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hardness is not reported (2), Alkalinity is not reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
It is unknown whether measured concentrations were not within 20% of nominal (4), It is not stated whether the organisms were randomly assigned to containers (1), Dilution water source is not specified whether the tap water is dechlorinated (2), Hardness not reported (2), Alkalinity not reported (2), Conductivity not reported (1), Random design not reported (2), Hypothesis tests (3).

Toxicity Data Summary

Daphnia magna

Study: Leicht W, Ruchs R, Londershausen M. 1996. Stability and biological activity of cyfluthrin isomers. Pesticide Science, 48:325-332.

Relevance
Score: 60 (No standard method, Endpoint, No toxicity value)
Rating: N

Toxicity Data Summary

Hyalella azteca

Study: Brander SM. Werner I, White JW, Deanovic LA. 2009. Toxicity of a dissolved pyrethroid mixture to *Hyalella azteca* at environmentally relevant concentrations. Environmental Toxicology and Chemistry, 28:1493-1499.

Relevance - Mortality
Score: 92.5 (control response not reported)
Rating: R

Reliability
Score: 67
Rating: L

Relevance – Protein content
Score: 70 (toxicity values not calculable, endpoint)
Rating: L

Reliability
Score: 65.5
Rating: L

Reference	**Brander *et al.* 2009**	***H. azteca***
Parameter	**Value**	**Comment**
Test method cited	USEPA 1994	WET test method
Phylum	Arthropoda	
Class	Crustacea - Malacostraca	
Order	Amphipoda	
Family	Hyalellidae	
Genus	*Hyalella*	
Species	*azteca*	
Family in North America?	yes	
Age/size at start of test/growth phase	7-14 d old	
Source of organisms	Commercial supplier	Aquatic Research Organisms
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	10 d	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Effect 2	Protein content of organism	Not clearly linked to survival, growth, or repro. for adult organisms
Control response 2	Fig. 6 (~8.2 mg/mL protein)	
Temperature	23 ± 2°C	
Test type	Static renewal, renewed	

Reference	**Brander *et al.* 2009**	***H. azteca***
Parameter	**Value**	**Comment**
	every 5 d	
Photoperiod/light intensity	16 h L:8 h D	
Dilution water	USEPA moderately hard water	Made from deionized water
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	Yes, every 2 d, and after water renewal	
Purity of test substance	98%	
Concentrations measured?	Yes, but some estimated values were used to calculate toxicity values in 2008 tests	
Measured is what % of nominal?	33-119%	
Chemical method documented?	Not reported, samples sent to lab for analysis	California Dept. of Fish and Game, Fish and Wildlife Water Pollution Control Lab.
Concentration of carrier (if any) in test solutions	0.025% methanol	
Concentration 1 Nom/Meas 2007/Est 2008 (µg/L)	0.0025/0.0029/0.002	6 reps, 10/rep
Concentration 2 Nom/Meas 2007/Est 2008 (µg/L)	0.0050/0.0051/0.004	6 reps, 10/rep
Concentration 3 Nom/Meas 2007/Est 2008 (µg/L)	0.0100/0.0104/0.008	6 reps, 10/rep
Concentration 4 Nom/Meas 2007/Meas 2008 (µg/L)	0.0120/0.0119/0.004	6 reps, 10/rep
Concentration 5 Nom/Meas 2007/Meas 2008 (µg/L)	0.0240/0.0254/0.008	6 reps, 10/rep
Concentration 6 Nom/Meas 2007/Meas 2008 (µg/L)	0.0480/0.0573/0.016	6 reps, 10/rep
Control	Solvent and dilution water	6 reps, 10/rep
LC_{50} (95% confidence interval) (µg/L)	10 d: 0.0057	Method: regression analysis
NOEC (µg/L)	Protein content: Not calculable	Method: NR p: 0.05 MSD: NR
LOEC (µg/L)	Protein content: Not calculable	Same as above

Reference	**Brander *et al.* 2009**	***H. azteca***
Parameter	**Value**	**Comment**
MATC (GeoMean NOEC,LOEC)	Protein content: Not calculable	
% control at NOEC	NR	
% of control LOEC	NR	

Notes:
The toxicity values of the protein content analysis could not be calculated because all of the surviving organisms from all concentrations tested were pooled together in a single group for analysis, thus, a dose-response relationship cannot be established for this endpoint. Although, there was a significant difference ($p<0.05$) in protein content between exposed organisms and control organisms (fig. 6).

Mortality Reliability points taken off for:
Documentation: Analytical method (4), Hardness (2), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8).
Acceptability: Control response (9), Measured concentrations within 20% of nominal (4), Appropriate duration (2), Organism size (3), Organisms randomized (1), Organism acclimation (1), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature (3), Conductivity (1), pH (2), Random design (2), Hypothesis tests (3).

Protein content Reliability points taken off for:
Documentation: Analytical method (4), Hardness (2), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Statistical methods (5), Point estimates (8), Minimum significant difference (2), % control of NOEC/LOEC (2).
Acceptability: Measured concentrations within 20% of nominal (4), Organism size (3), Organisms randomized (1), Organism acclimation (1), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature (3), Conductivity (1), pH (2), Random design (2), Statistical method (2), Hypothesis tests (3), Point estimates (3).

Toxicity Data Summary

Hyalella azteca

Weston DP, Jackson CJ. 2009. Use of Engineered Enzymes to Identify Organophosphate and Pyrethroid-Related Toxicity in Toxicity Identification Evaluations. Environ Sci Technol 43:5514-5520.

Relevance	Reliability
Score: 100	Score: 88
Rating: R	Rating: R

Reference	**Weston & Jackson 2009**	***H. azteca***
Parameter	**Value**	**Comment**
Test method cited	USEPA	Modified for H. azteca
Phylum	Arthropoda	
Class	Crustacea - Malacostraca	
Order	Amphipoda	
Family	Hyalellidae	
Genus	*Hyalella*	
Species	*azteca*	
Family in North America?	Yes	
Age/size at start of test/growth phase	7- 14 d†	
Source of organisms	Lab culture†	Weston Lab
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes†	
Animals randomized?	Yes†	
Test vessels randomized?	Yes†	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	median control survival was 95% (range 84-100%). Median solvent control survival for the acetone carrier was 98% (84-100%)	
Effect 2	Impaired swimming*	
Control response 2	Survivors never had impaired control response	
Temperature	23 °C	
Test type	Static renewal (48 h)	
Photoperiod/light intensity	16:8 (light:dark)	
Dilution water	EPA moderately hard water,	

Reference	**Weston & Jackson 2009**	***H. azteca***
Parameter	**Value**	**Comment**
	from purified water	
pH	7.5†	
Hardness	90 mg/L as $CaCO_3$ †	
Alkalinity	60 mg/L as $CaCO_3$ †	
Conductivity	335 umhos/cm†	
Dissolved Oxygen	7.4 mg/L†	
Feeding	Yes, but appropriate	DO depletion & sorption minimized by feeding 6h prior to renewal
Purity of test substance	> 98%†	
Concentrations measured?	Some were measured, then those recoveries were used to estimate the actual concentrations of all tested	
Measured is what % of nominal?	median 114% of nominal; range 64-189%	Pyrethroid conc. declined to a median of 34% of initial nominal conc. within 48 h (range <12-72%, *n* = 9).
Chemical method documented?	Yes	GC-uECD
Concentration of carrier (if any) in test solutions	Acetone, < 32 µL/L	
Concentration 1 Nom/Meas (µg/L)	5-8 conc. separated by a factor of 0.5 (e.g., 20, 10, 5, 2.5, 1.3 ng/L)	3 tests, 3 reps and 10/rep
Control	solvent	3 tests, 3 reps and 10/rep
LC_{50} (95% confidence interval) ng/L	1.7 (1.1-2.3) 2.3 (0.9-2.8) 3.1 (2.1-4.6)	Method: Probit
EC_{50} (95% confidence interval) ng/L	1.3 (1.1-1.5) 1.9 (1.5-2.3) 2.2 (1.1-3.0)	Method: Probit

Other notes:

†Indicates information was gathered or clarified via email communication with the author Dr. Donald Weston (dweston@berkeley.edu).

*Most impaired organisms were lying on their sides, able only to twitch one or more appendages. For those few individuals still able to swim, movement was poorly coordinated and swimming limited to only a few body lengths. Therefore, we also recorded the proportion of animals able to swim normally, with results reported as the median effective concentration (EC_{50}).

When spiking water or sediment with pesticides, samples to determine the actual pesticide concentration were taken from one concentration step in the midpoint of the range used. For the water tests, the initial water concentration was determined at time 0 and again when fresh solutions were prepared at 48 h. The two samples were either analyzed separately or as a composite. Samples were also taken of water that had been in the beakers for the maximum period (at the end of the first and second 48 h intervals, combined as a composite).

The average pyrethroid concentrations to which *H. azteca* were exposed were approximated as the nominal concentration minus one-half of the 66% nonenzymatic loss over 48 h (i.e., average actual concentration equal to 33% less than nominal). All reported water concentrations are actual values, derived from nominal concentrations adjusted by this factor.

Reliability Scoring
Documentation points taken off for: Nominal concentrations (3), Measured concentrations (3), Hypothesis tests (8)

Acceptability points taken off for: Meas. conc. w/in 20% of nom. (4), Conc. not > 2x water solubility (4), Hypothesis tests (3).

Toxicity Data Summary

Lepomis macrochirus

Study: Carlisle JC, Roney DJ. 1983. Acute Toxicity of Cyfluthrin Technical to Bluegill Sunfish. CDPR ID: 50317-003.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 80.5
Rating: R

Reference	**Carlisle & Roney 1983**	***L. macrochirus***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	*Lepomis*	
Species	*macrochirus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Average weight: 0.8 g	
Source of organisms	Fattig Fish hatchery	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	No	
Test vessels randomized?	No	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	None	
Temperature	20 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Dechlorinated tap	
pH	6.3-6.6	
Hardness	71 ppm	
Alkalinity	39 ppm	
Conductivity	NR	
Dissolved Oxygen	5.1-7.2 ppm	
Feeding	None during study	
Purity of test substance	87%	
Concentrations measured?	No	

Reference	**Carlisle & Roney 1983**		***L. macrochirus***
Parameter	**Value**		**Comment**
Measured is what % of nominal?	n/a		
Chemical method documented?	n/a		
Concentration of carrier (if any) in test solutions	1.3 uL/L		Acetone
Concentration 1 Nom/Meas (µg/L)	Nominal 0.1	Measured Not measured	1 rep with 10 organisms each
Concentration 2 Nom/Meas (µg/L)	0.2	Not measured	1 rep with 10 organisms each
Concentration 3 Nom/Meas (µg/L)	0.4	Not measured	1 rep with 10 organisms each
Concentration 4 Nom/Meas (µg/L)	0.8	Not measured	1 rep with 10 organisms each
Concentration 5 Nom/Meas (µg/L)	1.6	Not measured	1 rep with 10 organisms each
Concentration 6 Nom/Meas (µg/L)	3.2	Not measured	1 rep with 10 organisms each
Control	Solvent, water		1 rep with 10 organisms each
LC_{50} (µg/L)	96 hr: 1.5		Weil method (table for convenient calculation of median-effective dose (LD50 or ED50) and instruction of their use

Notes:
-This study can be found under with the study 50317-003 Mallard LC50
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
No acceptable standard method identified (5), It is unknown whether measured concentrations were not within 20% of nominal (4), It is unknown whether the organisms were randomly assigned to test containers (1), Conductivity not reported (1), It is unknown whether random block was utilized (2), Inadequate replication (2), The statistical method is not appropriate (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Lepomis macrochirus

Study: Gagliano GG. 1994. Acute toxicity of ^{14}C-cyfluthirn to the bluegill (*Lepomis macrochirus*) under flow-through conditions. Miles Incorporated Agriculture Division, Research and Development Dept. Environmental Research Section, Stilwell, KS. USEPA MRID: 454267-07.

Relevance
Score: 100
Rating: R

Reliability
Score: 91.5
Rating: R

Reference	**Gagliano 1994**	***L. macrochirus***
Parameter	**Value**	**Comment**
Test method cited	FIFRA Guide 71-1	Acute Toxicity test for Freshwater Fish
Phylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	*Lepomis*	
Species	*macrochirus*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Weight: 0.82 ± 0.39 g Length: 31.8 ± 4 mm	
Source of organisms	Osage Catfisheries, Osage Missouri	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 hr	
Data for multiple times?	24, 48, 72 hr	
Effect 1	Mortality	
Control response 1	0%	
Temperature	22 ± 1°C	
Test type	Flow Through	
Photoperiod/light intensity	16:8 Light Dark	
Dilution water	Blended Spring Water	
pH	7.2	
Hardness	48 mg/L	
Alkalinity	45 mg/L	
Conductivity	129 μmhos	

Reference	**Gagliano 1994**		***L. macrochirus***
Parameter	**Value**		**Comment**
Dissolved Oxygen	7.8-8.6 mg/L 89-98% saturation		
Feeding	None during test		
Purity of test substance	97.6%		
Concentrations measured?	No		
Measured is what % of nominal?	57-64%		
Chemical method documented?	Yes		
Concentration of carrier (if any) in test solutions	Max 90 µL/L		
Concentration 1 Nom/Meas (µg/L)	Nominal	Measured	
	0.194	0.111	1 Reps and 20 per
Concentration 2 Nom/Meas (µg/L)	0.324	0.187	1 Reps and 20 per
Concentration 3 Nom/Meas (µg/L)	0.54	0.348	1 Reps and 20 per
Concentration 4 Nom/Meas (µg/L)	0.9	0.509	1 Reps and 20 per
Concentration 5 Nom/Meas (µg/L)	1.5	0.845	1 Reps and 20 per
Concentration 6 Nom/Meas (µg/L)	2.5	1.567	1 Reps and 20 per
Control	Dilution water and solvent		1 Reps and 20 per
LC_{50} (µg/L)	24 h: $\geq$ 1.5 48 h: $\geq$ 1.15 72 h: 1.024 96 h: 0.998		Method: Probit (48 h), Binominal Probability (72, 96 h)

Notes:
LC_{50} calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
Hypothesis test only apply to chronic test (8).
Acceptability (3.8):
Measured Concentrations below 80% of Nominal (4), Replication was not adequate (2), Hypothesis tests do not apply to chronic tests (3).

Toxicity Data Summary

Mysidopsis bahia

Study: Johnson I, Ward GS, Drottar K, Coulombe W. 1985. Acute toxicity of cyfluthrin to the saltwater mysid, *Mysidopsis bahia.* Mobay Chemical Corporation. Environmental Science and Engineering, Inc. Gainesville, FL. Study number 90274. CDPR ID: 50317-090.

Relevance
Score: 75 (No standard method, saltwater)
Rating: L

Reliability
Score: 75.5
Rating: R

Reference	**Johnson *et al.* 1985**	***M. bahia***
Parameter	**Value**	**Comment**
Test method cited	Environmental science and Engineering Inc protocol	
Phylum	Arthropoda	
Class	Malacostraca	
Order	Mysida	
Family	Vespoidea	
Genus	*Mysidopsis*	
Species	*bahia*	
Family in North America?	Yes	
Age/size at start of test/growth phase	6 days old	
Source of organisms	Commercial Supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not specified	
Test duration	96 h	
Data for multiple times?	24, 48, 72 h	
Effect 1	Mortality	
Control response 1	5%	
Temperature	22-28 degrees C	
Test type	Flow Through	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Filtered natural seawater	
pH	7.7-8.4	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	4.6 ppm or 66% saturation	

Reference	**Johnson *et al.* 1985**		***M. bahia***
Parameter	**Value**		**Comment**
Feeding	Animals were fed during study		
Purity of test substance	90.5%		
Concentrations measured?	No		
Measured is what % of nominal?	Not measured		
Chemical method documented?	No		
Concentration of carrier (if any) in test solutions	0.1 mL/L		
Concentration 1 Nom/Meas (ng/L)	Nominal 1	Measured Not measured	2 reps 10 organisms each
Concentration 2 Nom/Meas (ng/L)	2.3	Not measured	2 reps 10 organisms each
Concentration 3 Nom/Meas (ng/L)	4.5	Not measured	2 reps 10 organisms each
Concentration 4 Nom/Meas (ng/L)	9.0	Not measured	2 reps 10 organisms each
Concentration 5 Nom/Meas (ng/L)	18	Not measured	2 reps 10 organisms each
Concentration 6 Nom/Meas (ng/L)	36	Not measured	2 reps 10 organisms each
Control	Solvent and water		2 reps 10 organisms each
LC_{50} (95% confidence interval) (ng/L)	24 h: 20.2 (16.3-25.8) 48 h: 8.04 (6.16-10.8) 72 h: 7.61 (5.82-10.2) 96 h: 6.37 (4.63-8.78)		Method: Moving Average (Stephan 1982)

Notes:
-This study can be found under with the study 50317-090 Mallard Repro 1986 study.
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hardness is not reported (2), Alkalinity is not reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
Standard Method not acceptable (5), It is unknown whether measured concentrations were not within 20% of nominal (4), Hardness not reported (2), Alkalinity is not reported (2), Temperature varied and was not held to 1 degree C (3), Conductivity not reported (1), It is unknown whether random block was utilized (2), Adequate replication was not done (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Mysidopsis bahia

Study: Surprenant DC. 1987. Acute toxicity of Baythroid to Mysid shrimp (*Mysidopsis bahia*) under flow-through conditions. Mobay Chemical Corporation. Springborn Bionomics Inc. Aquatic Toxicology Laboratory, Wareham, MA. Study number 94220. CDPR ID: 50317-059.

Relevance
Score: 85 (Saltwater)
Rating: L

Reliability
Score: 84.5
Rating: R

Reference	**Surprenant 1987**	***M. bahia***
Parameter	**Value**	**Comment**
Test method cited	EPA and Fifra, 40 CFR part 160	
Phylum	Arthropoda	
Class	Malacostraca	
Order	Mysida	
Family	Vespoidea	
Genus	*Mysidopsis*	
Species	*bahia*	
Family in North America?	Yes	
Age/size at start of test/growth phase	≤ 24 hours old	
Source of organisms	Laboratory Cultures	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 hours	
Data for multiple times?	24, 48, 72, 96 hours	
Effect 1	Mortality	
Control response 1	5%	
Temperature	25 ± 1°C	
Test type	Flow Through	
Photoperiod/light intensity	16:8	
Dilution water	Seawater Filtered	
pH	7.7-8	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	7.4-8.1 mg/L	

Reference	**Surprenant 1987**		***M. bahia***
Parameter	**Value**		**Comment**
Feeding	Not stated		
Purity of test substance	97.4%		
Concentrations measured?	Yes		
Measured is what % of nominal?	66-138%		
Chemical method documented?	Yes, LSC		
Concentration of carrier (if any) in test solutions	9 ug/L		Acetone
Concentration 1 Nom/Meas (µg/L)	Nominal 0.008	Measured 0.00608	 2 reps with 20 orgs
Concentration 2 Nom/Meas (µg/L)	0.004	0.00264	2 reps with 20 orgs
Concentration 3 Nom/Meas (µg/L)	0.002	0.00142	2 reps with 20 orgs
Concentration 4 Nom/Meas (µg/L)	0.001	0.00081	2 reps with 20 orgs
Concentration 5 Nom/Meas (µg/L)	0.0005	0.00069	2 reps with 20 orgs
Control	Dilution water and solvent		
LC_{50} (95% confidence limits) (µg/L)	24 h: 0.00608 (0.00468-0.01235) 48 h: 0.00384 (0.00318-0.00493) 72 h: 0.00334 (0.00273-0.00426) 96 h: 0.00246 (0.00196-0.00326)		Method: Moving Average Method

Notes:
Salinity = 30-34 o/oo
LC50 values calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
No hardness reported (2), No Alkalinity reported (2), No conductivity reported (2), Hypothesis tests do not apply (8).
Acceptability (3.8):
Measured concentrations were below 80% of nominal (4), It is not known whether the organisms were fed during the study (3), No hardness reported (2), No Alkalinity reported (2), No conductivity reported (1), Replication not adequate (2), The hypothesis test does not apply (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Bowers LM. 1994. Acute toxicity of ^{14}C-Cyfluthrin to Rainbow Trout (*Oncorhynchus mykiss*) under Flow- through Conditions. Miles Incorporated, Agriculture Division, Research and Development Dept., Environmental Research Section Stilwell, KS. US EPA MRID: 45426705, CDPR ID: 50317-173.

Relevance
Score: 100
Rating: R

Reliability
Score: 91.5
Rating: R

Reference	**Bowers 1994**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	US EPA	
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	
Species	*mykiss*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Length: 43.3 ± 4.0 mm Weight: 1.4 ± 0.46 g	
Source of organisms	Osage Catfisheries	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	24, 48, 72 h	
Effect 1	Mortality	
Control response 1	0%	
Temperature	12 ± 1°C	
Test type	Flow Through	
Photoperiod/light intensity	16:8	
Dilution water	Blended spring water and treated city water	
pH	6.4-7.4	
Hardness	55 mg/L	
Alkalinity	44 mg/L	
Conductivity	138 umhos/cm	
Dissolved Oxygen	9.4-10.2 mg/L	

Reference	**Bowers 1994**		***O. mykiss***
Parameter	**Value**		**Comment**
Feeding	None during study		
Purity of test substance	97.6%		
Concentrations measured?	Yes		
Measured is what % of nominal?	64-80%		
Chemical method documented?	Yes, LSC		
Concentration of carrier (if any) in test solutions	100 uL/0.991 L DMF		
Concentration 1 Nom/Meas (µg/L)	Nominal 0.130	Measured 0.1045	1 Rep and 20 per
Concentration 2 Nom/Meas (µg/L)	0.216	0.1458	1 Rep and 20 per
Concentration 3 Nom/Meas (µg/L)	0.360	0.2401	1 Rep and 20 per
Concentration 4 Nom/Meas (µg/L)	0.6	0.4323	1 Rep and 20 per
Concentration 5 Nom/Meas (µg/L)	1.0	0.6421	1 Rep and 20 per
Control	Dilution water and solvent		1 Rep and 20 per
LC_{50} (µg/L)	24 h: > 0.642 48 h: 0.497 (0.432-0.642) 72 h: 0.352 (0.240-0.432) 96 h: 0.302 (0.240-0.432)		Method: Binomial Probability

Notes:

LC50 calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
Hypothesis tests do not apply (8)
Acceptability (3.8):
Measured concentrations were not within 20% of the nominal (4), Inadequate replication (2), Hypothesis tests only apply to Chronic tests (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Carlisle JC. 1984a. Toxicity of cyfluthrin (Baythroid) to rainbow trout early life stages. Mobay study number 83-666-05. CDPR Study ID: 50317-027, report number 86561.

Relevance
Score: 75 (no toxicity values)
Rating: L

Reliability
Score: 73
Rating: R

Reference	**Carlisle 1984a**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	Formerly *Salmo*
Species	*mykiss*	*gairdneri*
Family in North America?	yes	
Age/size at start of test/growth phase	Embryos and larvae	
Source of organisms	Commercial supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes, for 5 d	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	60 d	
Data for multiple times?	Yes, 24, 48, 72 h	
Effect 1	Mean days incubation	
Control response 1	7.25 d	
Effect 2	Total hatch	
Control response 2	99%	
Effect 3	Total Swimup	
Control response 3	98%	
Effect 4	Survivors	
Control response 4	60%	
Effect 5	Biomass (g)	
Control response 5	11.15 g	
Effect 6	Mean Weight (mg)	
Control response 6	377.5 mg	
Temperature	7.5-12.9 °C	
Test type	Flow-through	

Reference	**Carlisle 1984a**	***O. mykiss***
Parameter	**Value**	**Comment**
Photoperiod/light intensity	16L:8D	
Dilution water	Dechlorinated tapwater	
pH	6.7-7.8	
Hardness	120-192mg/L	
Alkalinity	48-64 mg/L	
Conductivity	NR	
Dissolved Oxygen	8.6-11.2 mg/L	
Feeding	Not described or reported	
Purity of test substance	87%	
Concentrations measured?	Yes	
Measured is what % of nominal?	30-640%	
Chemical method documented?	Yes, GC-ECD	
Concentration of carrier (if any) in test solutions	% DMSO 0.4 mL/1000 mL, dil by 1000	
Concentration 1 Nom/Meas (µg/L)	0.025/0.160	2 reps, 50/rep
Concentration 2 Nom/Meas (µg/L)	0.050/0.100	2 reps, 50/rep
Concentration 3 Nom/Meas (µg/L)	0.100/0.030	2 reps, 50/rep
Concentration 4 Nom/Meas (µg/L)	0.200/0.186	2 reps, 50/rep
Concentration 5 Nom/Meas (µg/L)	0.400/0.123	2 reps, 50/rep
Control	Not described, meas. 0.098 µg/L cyf	2 reps, 50/rep
NOEC (µg/L)	Reported as 0.400 µg/L	Method: ANOVA, Duncan's multiple range test, Probit p: 0.05 MSD:
LOEC (µg/L)	Not calculable	
MATC (GeoMean NOEC,LOEC)	Not calculable	
% control at NOEC	Days Inc: 7 d/7.25 d Total Hatch: 50/49.5 Total Swimup: 47/49 Survivors: 28/30 Biomass: 11.8 g/11.15 g Mean Wt: 426.5 mg/377.5 mg	

Notes:
Test is inconclusive because no effects were observed. NOEC is reported as the highest concentration tested, and it is not possible to calculate a MATC.

Analytical methods are questionable; they do not believe there were problems with the dilution system because stock solutions and dilution ratios were checked daily.

Reliability points taken off for:
Documentation: Control type (8), Conductivity (2), Statistical significance (2), MSD (2), Point estimates (8)
Acceptability: Acceptable standard method (5), Appropriate control (6), Measured conc. w/in 20% of nominal (4), Organisms randomized (1), Feeding (3), Temperature variation (3), Conductivity (1), Random design (2), Adequate replication (2), MSD (1), LOEC reasonable compared to control (1), Point estimates (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Carlisle JC. 1984b. Acute Toxicity of Cyfluthrin (Baythroid) to Rainbow Trout. CDPR 50317-027.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 81
Rating: R

Reference	**Carlisle 1984b**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	
Species	*mykiss*	
Family in North America?	Yes	
Age/size at start of test/growth phase	2.3-2.6 g	
Source of organisms	Mt. Lassen Trout Farms	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	No	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	0%	
Temperature	12 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Tap water	Not specified whether dechlorinated
pH	7.1-7.9	
Hardness	153-178 mg/L CaCO3	
Alkalinity	49-60 mg/L CaCO3	
Conductivity	NR	
Dissolved Oxygen	4.7-10.1 mg/L	
Feeding	None during study	

Reference	**Carlisle 1984b**		***O. mykiss***
Parameter	**Value**		**Comment**
Purity of test substance	87%		
Concentrations measured?	No		
Measured is what % of nominal?	n/a		
Chemical method documented?	n/a		
Concentration of carrier (if any) in test solutions	100 mg/L DMF		
Concentration 1 Nom/Meas (µg/L)	Nominal 1.5	Measured Not measured	1 rep with 10 organisms each
Concentration 2 Nom/Meas (µg/L)	2.2	Not measured	1 rep with 10 organisms each
Concentration 3 Nom/Meas (µg/L)	3.2	Not measured	1 rep with 10 organisms each
Concentration 4 Nom/Meas (µg/L)	4.7	Not measured	1 rep with 10 organisms each
Concentration 5 Nom/Meas (µg/L)	6.9	Not measured	1 rep with 10 organisms each
Concentration 6 Nom/Meas (µg/L)	10.0	Not measured	1 rep with 10 organisms each
Control	Solvent and water		1 rep with 10 organisms each
LC_{50} (µg/L)	96 h: 2.9 (2.5-3.3)		Method: Weil method

Notes:
-This study can be found under with the study 50317-027 Mallard LC50.
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
No acceptable standard method identified (5), It is unknown whether measured concentrations were not within 20% of nominal (4), Dilution water source is not specified whether the tap water is dechlorinated (2), Conductivity not reported (1), It is unknown whether random block was utilized (2), Inadequate replication (2), The statistical method is not appropriate (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Carlisle JC. 1985. Toxicity of cyfluthrin (Baythroid) technical to early life stages of rainbow trout. Mobay Chemical Co. Study No. 85-666-01. CDPR ID: 50317-090.

Relevance		Reliability
Score: 90	(No std method reported)	Score: 84
Rating: R		Rating: R

Reference	**Carlisle 1985**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	
Species	*mykiss*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Eggs	
Source of organisms	Commercial supplier	Mt. Lassen Trout Farm
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	Yes	
Test duration	58 d	
Data for multiple times?	No	
Effect 1	Total swimups	
Control response 1	98%	
Effect 2	Larval mortality	
Control response 2	7%	
Effect 3	Biomass/chamber	
Control response 3	40.3 g	
Effect 4	Mean weight/fish	
Control response 4	435 mg	
Temperature	9.4 ± 2.5°C	
Test type	FT	
Photoperiod/light intensity	16 L:8 D	
Dilution water	Filtered tapwater	
pH	6.5-7.8	

Reference	**Carlisle 1985**	***O. mykiss***
Parameter	**Value**	**Comment**
Hardness	94-139 mg/L	
Alkalinity	6-16 mg/L	
Conductivity	NR	
Dissolved Oxygen	6.5-11.9 mg/L	
Feeding	3x per day	
Purity of test substance	96%	
Concentrations measured?	Yes	
Measured is what % of nominal?	GC: 32-48%, LSC: 92-115%	
Chemical method documented?	GC-ECD and LSC	
Concentration of carrier (if any) in test solutions	0.04 mL/L	
Concentration 1 Nom/Meas (ng/L)	25/10	2 reps, 50 orgs/rep
Concentration 2 Nom/Meas (ng/L)	50/17.7	2 reps, 50 orgs/rep
Concentration 3 Nom/Meas (ng/L)	100/31.8	2 reps, 50 orgs/rep
Concentration 4 Nom/Meas (ng/L)	200/84.8	2 reps, 50 orgs/rep
Concentration 5 Nom/Meas (ng/L)	400/160	2 reps, 50 orgs/rep
Control	Solvent	2 reps, 50 orgs/rep
NOEC (ng/L)	Total swimups: 84.8 Larval mortality: 17.7 Biomass: 10 * Weight/fish: 10*	Method: Waller-Duncan K-ratio t-test p: 0.05 MSD: NR
LOEC (ng/L)	Total swimups: 160 Larval mortality: 31.8 Biomass: 17.7 * Weight/fish: 17.7 *	Same as above
MATC (GeoMean NOEC,LOEC)	Biomass & Weight: 13.3 ng/L	
% control at NOEC	Biomass: 93.1% Weight: 96.3%	
% of control LOEC	Biomass: 60.8% Weight: 60.2%	

Notes:
-NOEC/LOEC calculated based on mean measured concentrations, measured by GC-ECD.
-Embryonic mortality, Hatchability, and Days to hatch were also examined but no effects were observed at any concentration for those endpoints.

Reliability points taken off for:
Documentation: Conductivity (2), MSD (2), Point estimates (8).
Acceptability: Standard method (5), Measured conc w/in 20% nominal (4), Organisms randomized (1), Temperature range (3), Conductivity (1), Replication (2), MSD (1), Point estimates (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Carlisle JC, Carsel MA. 1983a. Acute toxicity of cyfluthrin technical to Rainbow Trout 83-066-02. Mobay Chemical Corporation, Corporate Toxicology Dept. Environmental Health Research, Stilwell, KS. Study number 85701. CDPR ID: 50317-003.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 81.5
Rating: R

Reference	**Carlisle & Carsel 1983a**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	None cited	
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	
Species	*mykiss*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Average weight: 0.3 g	
Source of organisms	Mt. Lassen Trout Farms	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	No	
Test vessels randomized?	No	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	0%	
Temperature	13 ± 1°C	
Test type	Static	
Photoperiod/light intensity	16:8 light dark	
Dilution water	Dechlorinated tap	
pH	6.8-7.5	
Hardness	67 ppm	
Alkalinity	39 ppm	
Conductivity	NR	
Dissolved Oxygen	6.2-10.6 ppm	
Feeding	None during study	

Reference	**Carlisle & Carsel 1983a**		***O. mykiss***
Parameter	**Value**		**Comment**
Purity of test substance	87%		
Concentrations measured?	No		
Measured is what % of nominal?	n/a		
Chemical method documented?	n/a		
Concentration of carrier (if any) in test solutions	5 mL/15 L		Dimethylformamide
Concentration 1 Nom/Meas (µg/L)	Nominal 0.25	Measured Not measured	1 rep with 10 organisms each
Concentration 2 Nom/Meas (µg/L)	0.35	Not measured	1 rep with 10 organisms each
Concentration 3 Nom/Meas (µg/L)	0.5	Not measured	1 rep with 10 organisms each
Concentration 4 Nom/Meas (µg/L)	0.71	Not measured	1 rep with 10 organisms each
Concentration 5 Nom/Meas (µg/L)	1.00	Not measured	1 rep with 10 organisms each
Control	Solvent		1 rep with 10 organisms each
LC_{50} (µg/L)	96 h: 0.68		Weil method (table for convenient calculation of median-effective dose (LD50 or ED50) and instruction of their use

Notes:
-This study can be found under with the study 50317-003 Mallard LC50
-Calculations based on nominal concentrations.

Reliability points taken off for:
Documentation (3.7):
No analytical method described to measure chemical concentrations (4), No measured concentrations (3), No conductivity reported (2), Hypothesis tests were not applicable for this acute study (8).
Acceptability (3.8):
No acceptable standard method identified (5), It is unknown whether measured concentrations were not within 20% of nominal (4), It is unknown whether the organisms were randomly assigned to test containers (1), Conductivity not reported (1), It is unknown whether random block was utilized (2), Inadequate replication (2), The statistical method is not appropriate (2), Hypothesis tests are not applicable to this acute study (3).

Toxicity Data Summary

Oncorhynchus mykiss

Study: Gagliano GG, Bowers LM. 1994. Acute Toxicity of ^{14}C-Cyfluthrin to the Rainbow Trout (*Oncorhynchus mykiss*) under Flow-Through conditions. Miles Incorporated Agriculture Division, Research and Development Dept. Environmental Research Section, Stilwell, KS. US EPA MRID: 454267-08.

Relevance
Score: 100
Rating: R

Reliability
Score: 91.5
Rating: R

Reference	**Gagliano & Bowers 1994**	***O. mykiss***
Parameter	**Value**	**Comment**
Test method cited	FIFRA Guide 71-1	Acute Toxicity test for Freshwater Fish
Phylum	Chordata	
Class	Osteichthyes	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Oncorhynchus*	
Species	*mykiss*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Weight: 0.92 ± 0.34 g Length: 39 ± 4 mm	
Source of organisms	Black Canyon Trout Hatchery Grace, ID	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 hr	
Data for multiple times?	24, 48, 72 hr	
Effect 1	Mortality	
Control response 1	0%	
Temperature	11 ± 1°C	
Test type	Flow Through	
Photoperiod/light intensity	16:8 Light Dark	
Dilution water	Spring Water mixed with dechlorinated tapwater	
pH	7.7	
Hardness	50 mg/L	
Alkalinity	39 mg/L	

Reference	**Gagliano & Bowers 1994**		***O. mykiss***
Parameter	**Value**		**Comment**
Conductivity	127 µmhos		
Dissolved Oxygen	8.9-10.7 mg/L 83-99% saturation		
Feeding	None during test		
Purity of test substance	97.6%		
Concentrations measured?	Yes		
Measured is what % of nominal?	46-69%		
Chemical method documented?	Yes, LSC		
Concentration of carrier (if any) in test solutions	Max 90 µL/L		
Concentration 1 Nom/Meas (µg/L)	Nominal	Measured Mean	1 Reps and 20 per
	0.08	0.0407	
Concentration 2 Nom/Meas (µg/L)	0.13	0.063	1 Reps and 20 per
Concentration 3 Nom/Meas (µg/L)	0.22	0.102	1 Reps and 20 per
Concentration 4 Nom/Meas (µg/L)	0.36	0.173	1 Reps and 20 per
Concentration 5 Nom/Meas (µg/L)	0.6	0.304	1 Reps and 20 per
Concentration 6 Nom/Meas (µg/L)	1	0.699	1 Reps and 20 per
Control	Dilution water and solvent		1 Reps and 20 per
LC_{50} (µg/L)	24 h: $\geq$ 0.699 48 h: 0.309 72 h: 0.251 96 h: 0.209		Method: Probit

Notes:

LC_{50} calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
Hypothesis test only apply to chronic test (8).
Acceptability (3.8):
Measured Concentrations below 80% of Nominal (4), Replication was not adequate (2), Hypothesis tests do not apply to acute tests (3).

Toxicity Data Summary

Oreochromis niloticus

Study: Benli ACK. 2005. Investigation of acute toxicity of cyfluthrin on tilapia fry (Oreochromis niloticus L. 1758). Environmental Toxicology and Pharmacology 20: 279-282.

Relevance

Rating: N → Unusable because all conc > 2x water solubility

Toxicity Data Summary

Pimephales promelas

Study: Heath S, Bennett WA, Kennedy J, Beitinger TL. 1994. Heat and cold tolerance of the fathead minnow, *Pimephales promelas,* exposed to the synthetic pyrethroid cyfluthrin. Can. J. Fish. Aquat. Sci. 51: 437-440.

Relevance
Score: 77.5 (Chemical purity, No control response)
Rating: L

Reliability
Score: 55.5
Rating: N

Reference	**Heath *et al.* 1994**	***P. promelas***
Parameter	**Value**	**Comment**
Test method cited	US EPA 1975	
Phylum	Chordata	
Class	Osteichthyes	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 48 h	
Source of organisms	Lab culture	Univ. of N. Texas
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	23	
Test type	Static	
Photoperiod/light intensity	NR	
Dilution water	Dechlorinated tapwater	
pH	8	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	Not during test	

Reference	**Heath *et al.* 1994**	***P. promelas***
Parameter	**Value**	**Comment**
Purity of test substance	NR	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes	GC method
Concentration of carrier (if any) in test solutions	Acetone, % NR	
Concentration 1 Nom/Meas (µg/L)	Not reported	NR
Control	Solvent and Dil. Water	
LC50; indicate calculation method	96 h: 1.08 ug/L, fiducial interval: (0.78-1.49 ug/L)	Probit

Reliability points taken off for:
Documentation: Chemical purity (5), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Conductivity (2), Photoperiod (3), Hypothesis tests (8)
Acceptability: Control response (9), Chemical purity (10), Meas. Concentrations 20% Nom (4), Carrier solvent ≤ 0.5 mL/L (4), Organisms randomly assigned to containers (1), Adequate #/rep (2), Exposure type (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Conductivity (1), Photoperiod (2), Adequate number of concentrations (3), Appropriate spacing between concentrations (2), Random/block design (2), Adequate replication (2), Hypothesis tests (3).

Toxicity Data Summary

Pimephales promelas

Study: Rhodes JE, McAllister WA, Leak T, Stuerman L. 1990. Full life-cycle Toxicity of ^{14}C cyfluthrin (Baythroid ®) to the Fathead Minnow (*Pimephales promelas*) under flow through conditions. CDPR ID: 50317-110.

Relevance
Score: 100
Rating:R

Reliability
Score: 93.5
Rating: R

Reference	**Rhodes *et al.* 1990**	***P. promelas***
Parameter	**Value**	**Comment**
Test method cited	US EPA 40 CFR Section 158.145 Guideline No 72-4	
Phylum	Chordata	
Class	Osteichthyes	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Eggs < 24 hr post fertilization	
Source of organisms	U.S. Fish and Wildlife services	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	301 days post hatch	
Data for multiple times?	Yes	
Effect 1	% Hatch	
Control response 1	F0: 78%, F1: 88%	
Effect 2	Survival (7-60 d post-hatch)	
Control response 2	F0: 92.5%, F1: 88.5%	
Effect 3	Survival (61-120 d post-hatch)	
Control response 3	F0: 99%	
Effect 4	Length	Weight
Control response 4	30 d: F0 - 20.2 mm 60 d: F0 - 33.8 mm, F1: 90d: F0 – 40.9 mm	60 d F1: 90 d F0: 1449 mg 120 d F0: 1940 mg

Reference	**Rhodes *et al.* 1990**		***P. promelas***
Parameter	**Value**		**Comment**
	120d: F0 – 45.75 mm		
Effect 5	Reproduction (eggs/pair/d)		
Control response 5	Dil water: 38.2, Solv: 19.1		
Temperature	25 ± 1°C		
Test type	Flow Through		
Photoperiod/light intensity	Varied depending on simulated date		
Dilution water	Well water		
pH	7.5		
Hardness	24-48 mg/L		
Alkalinity	30-60 mg/L		
Conductivity	68-153 µS		
Dissolved Oxygen	60.8-88.6% saturation		
Feeding	Yes		Chronic study
Purity of test substance	99%		
Concentrations measured?	Yes		
Measured is what % of nominal?	44-125%		
Chemical method documented?	LSC		
Concentration of carrier (if any) in test solutions	0.0125 mL/L		Acetone
Concentration 1 Nom/Meas (µg/L)	Nominal 0.018	Meas 0.016	35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
Concentration 2 Nom/Meas (µg/L)	0.035	0.031	35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
Concentration 3 Nom/Meas (µg/L)	0.065	0.063	35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
Concentration 4 Nom/Meas (µg/L)	0.14	0.13	35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
Concentration 5 Nom/Meas (µg/L)	0.29	0.25	35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
Control	Acetone and water		35 eggs per 4 reps- hatched fish were continually separated further as test days increased.
LC_{50} (µg/L)	24 h: > 4 96 h: 2.49		Method: Not specified
NOEC (µg/L)	Fo survival 7-61 d: **0.14** Fo survival 61-120 d: **0.14** F1 % hatch: **0.14** F1 survival 0-60 d: **0.14**		Method: Frequency analysis and fisher's exact test p: ≤0.05 MSD: NR

Reference	**Rhodes *et al.* 1990**	***P. promelas***
Parameter	**Value**	**Comment**
LOEC (µg/L)	Fo survival 7-61 d: **0.29** Fo survival 61-120 d: **0.29** F1 % hatch: **0.29** F1 survival 0-60 d: **0.29**	Same as above
MATC (GeoMean NOEC,LOEC)	0.2 µg/L	
% control at NOEC	Fo survival day 7-61 = 97.3% Fo survival day 61-120 = 92.6% F1 % hatch = 107% F1 survival 0-60 d: 109%	
% of control LOEC	Fo survival day 7-61 = 57.3% Fo survival day 61-120 = 80.8% F1 % hatch = 82.8% F1 survival 0-60 d = 84.7%	

Notes:
-Also 96 h LC50 data available, but doesn't rate well, not well described.
-Calculations based on measured concentrations.
-No effect observed for the following endpoints: F0 % Hatch, F0 survival 120-153 d Post-hatch , F0 survival 153-301 d Post-hatch, F0 weight, F1 length, F1 weight 0-60 d, F1 length 0-60 d, Reproduction effects.
-Bioconcentration factors reported: eggs (240-300x), embryo (390-660x), larva (1200x), pre-spawn adult (2100-2400x), post-spawn adult male (720-1300x), post-spawn adult female (1800-2100x).

Reliability points taken off for:
Documentation (3.7):
Minimum significant difference is not reported (1), Point estimates are not relevant for this chronic study (8).
Acceptability (3.8):
Minimum significant difference is not reported (1), Point estimates are not relevant for this chronic study (3).

Toxicity Data Summary

Procambarus clarkii

Study: Surprenant DC. 1990. Acute Toxicity of ^{14}C-®Baythroid to Crayfish (*Procambarus clarkii*) under Flow through Conditions. CDPR ID: 50317-112.

Relevance
Score: 100
Rating: R

Reliability
Score: 90.5
Rating: R

Reference	**Surprenant 1990**	***P. clarkii***
Parameter	**Value**	**Comment**
Test method cited	ASTM 1980	
Phylum	Arthropoda	
Class	Malacostraca	
Order	Decapoda	
Family	Cambaridae	
Genus	*Procambarus*	
Species	*clarkii*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Average length: 29 mm Average weight: 0.59 g	
Source of organisms	Brood stocks	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 hr	
Data for multiple times?	24, 48, 72 hr	
Effect 1	Mortality	
Control response 1	0%	
Temperature	20 ± 1°C	
Test type	Flow Through	
Photoperiod/light intensity	16 L:8 D	
Dilution water	Well water	
pH	7.0-7.1	
Hardness	26 mg/L	
Alkalinity	24-25 mg/L	
Conductivity	90 µmhos/cm	
Dissolved Oxygen	93-94%	
Feeding	Not stated	
Purity of test substance	97%	
Concentrations measured?	Yes	

Reference	**Surprenant 1990**		***P. clarkii***
Parameter	**Value**		**Comment**
Measured is what % of nominal?	58-79%		
Chemical method documented?	Yes, LSC, GC-ECD		
Concentration of carrier (if any) in test solutions	14uLacetone/L		
Concentration 1 Nom/Meas (µg/L)	Nominal 0.1	Measured 0.0787	2 Rep and 10 per
Concentration 2 Nom/Meas (µg/L)	0.065	0.0399	2 Rep and 10 per
Concentration 3 Nom/Meas (µg/L)	0.042	0.0243	2 Rep and 10 per
Concentration 4 Nom/Meas (µg/L)	0.027	0.0167	2 Rep and 10 per
Concentration 5 Nom/Meas (µg/L)	0.018	0.0112	2 Rep and 10 per
Control	Acetone and water		2 Rep and 10 per
LC_{50} (µg/L)	24 h: > 0.079 48 h: > 0.079 72 h: > 0.079 96 h: 0.062		Method: Moving average angle analysis

Notes:

LC_{50} calculated based on measured concentrations.

Reliability points taken off for:
Documentation (3.7):
Hypothesis tests do not apply (8)
Acceptability (3.8):
Measured concentrations were not within 20% of the nominal (4), It is not specified whether the organisms were fed during the study (3), It is not specified whether the study was conducted with random block design (2), Adequate replication (2)

Toxicity Data Summary

Salmo salar

Study: Sievers G, Palacios P, Inostroza R, Dolz H. 1995. Evaluation of the toxicity of 8 insecticides in *Salmo salar* and the *in vitro* effects against the isopode parasite, *Ceratothoa gaudichuadii*. Aquaculture, 134: 9-16.

Relevance
Rating: N → Not usable because all conc. > 2x water solubility, or formulation

Toxicity Data Summary

Scenedesmus subspicatus

Study: Heimbach F. 1984. Growth inhibition of green algae (*Scenedesmus subspicatus*) by FCR 1272 (Technical). Bayer Report number 88884. CDPR ID: 50317-090.

The reported NOEC is 0.1 mg/L, which is > 2x the water solubility (2.3 μg/L).
→ N (not relevant)